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Manual of Naval Preventive Medicine

Chapter 8

NAVY ENTOMOLOGY AND PEST CONTROL TECHNOLOGY

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Chapter 8
Manual of Naval Preventive Medicine
Navy Entomology and Pest Control Technology

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To: Holders of the Manual of the Naval Preventive Medicine

1. Purpose. This revision reflects the latest Navy entomology and pest control technology.

2. Background. This revision reflects the latest Navy entomology guidance and updates information and recommendations to reflect current Environmental Protection Agency (EPA) guidance, industry best practices, and to incorporate pest control tools authorized by the Armed Forces Pest Management Board (AFPMB).

3. Action. Replace entire chapter 8 with this version.

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SECTION I. NAVY ORGANIZATION FOR MEDICAL ENTOMOLOGY PROGRAMS

8-1. Definitions of Vector and Pests

1. Vectors are living organisms that transmit infectious agents from a source or organism to other living organisms. Vectors spread disease through two types of transmission: mechanical and biological. Mechanical transmission occurs when a vector picks up the infectious agent on the outside its body and physically transmits the agent. An example of mechanical transmission is filth flies carrying diarrheal disease. Biological transmission occurs when an infectious agent completes part of its life cycle within the vector. An example of biological transmission is when a mosquito transmits a virus such as yellow fever.

2. Pests are living organisms that cause harm to humans or human interests and property. Vectors are pests due to their ability to transmit disease. Other pests may be destructive to structures, stored products, grounds, and other material properties.

8-2. Policies for Pest Control

1. A list of entomology and pest control references and helpful resources is provided in Appendix A. Appendix B contains a selection of photographs and images of pests of concern for Department of the Navy vessels and installations. Appendix C contains a list of acronyms used in this chapter.

2. Reference (a) provides basic standards and policies governing the Department of Defense (DoD) pest control programs, including those conducted by the Navy. This publication establishes minimum levels of pest control for DoD installations as well as program policies for pest management implementation.

3. References (b) and (c) outline pest control responsibilities and functions of the offices and commands of the Department of the Navy and establish policies to provide maximum effectiveness, efficiency, and safety in pest control operations.

a. Shore Activities. Commanders of all shore activities of the Department of the Navy bear the basic responsibility for the maintenance of an adequate vector and economic pest control program. They delegate this responsibility to the medical and public works departments. The public works department must conduct pest control operations as a scheduled part of performed services. The supporting Navy Medicine Readiness and Training Command (NAVMEDREAD-TRNCMD) and Navy Medicine Readiness and Training Unit (NAVMEDREADTRNUNIT) medical department must provide surveillance, recommend vector control measures, and determine that all activities are conducted safely. The public works and medical departments should jointly plan the activity's pest control program to ensure maximum effectiveness, efficiency, and safety.

b. Commands Afloat. Commanders afloat are responsible for maintaining effective and safe shipboard pest control programs. The medical department is responsible for the operation and supervision of the pest control program. Guidance can be found in reference (d).

8-3. Specific Responsibilities of the NAVMEDREADTRNCMD and NAVMEDREADTRNUNIT Medical Department

1. The NAVMEDREADTRNCMD and NAVMEDREADTRNUNIT medical department is responsible to the commanding officer for:

a. Inspections and surveys to determine the species, source, location, and density of disease vectors and nuisance pests.

b. Recommendations relating to sanitation standards and practices affecting the presence and abundance of pests and use of control methods.

c. Evaluations of the effectiveness of control measures.

d. Inspections and recommendations to ensure pesticides are used safely following current directives.

e. Provision of information on all appropriate personal protective measures.

f. Coordination with civilian and other governmental agencies having pest control problems that may affect naval personnel on or in the vicinity of a command.

g. Compliance with all appropriate public health quarantine measures. Reviews and approvals of activity pest management plans.

2. The commanding officer may charge the NAVMEDREADTRNCMD and NAVMEDREADTRNUNIT and operational medical department with responsibility for all operational phases of the vector control program:

a. In the event of a vector-borne disease outbreak.

b. In the absence of a public works department such as at certain shore installations, onboard ships, and with troops in the field.

c. In the control of vectors infesting humans (e.g., lice, mites).

d. In disaster situations.

8-4. Location and Responsibilities of Navy Medical Entomologists

1. Navy medical entomologists are assigned to the Navy Entomology Center of Excellence (NAVENTOCTR) in Jacksonville, FL, Navy Environmental and Preventive Medicine Units (NAVENPVNTMEDU) in Norfolk, VA (TWO); San Diego, CA (FIVE); Pearl Harbor, HI (SIX), and Rota, Spain (SEVEN); and to the Preventive Medicine Section 1st Medical Logistics Group (MLG), Camp Pendleton, CA; 2nd MLG, Camp Lejeune, NC; and 3rd MLG, Okinawa, Japan.

2. Navy medical entomologists assigned research responsibilities are assigned to the Naval Medical Research Unit (NAMRU) Asia, Singapore, NAMRU-3, Sigonella, Italy, and NAMRU-6, Lima, Peru.

3. Medical entomologists at NAVENTOCTR and NAVENPVNTMEDU locations, when authorized by proper authority, may conduct vector control operations for the purpose of training personnel; field testing new methods, materials and equipment; or providing area-wide vector control services that involve the use of specialized equipment.

4. The mission of NAVENTOCTR and NAVENPVNTMEDU:

a. NAVENTOCTR is the Navy and Marine Corps' Center of Excellence for operational entomology located at Naval Air Station Jacksonville, FL. NAVENTOCTR's unique DoD mission is to evaluate novel products, pesticides, and application technologies to better protect deployed forces from vectors of disease. NAVENTOCTR delivers force health protection through operational vector surveillance and control to enhance warfighter readiness. NAVENTOCTR also provides operational medical entomology and pest management training to DoD military and civilian personnel and is the program manager for the Navy shipboard pest management program. NAVENTOCTR's training department head is the AFPMB authorized DoD Pesticide Applicator Certification certifying official and the authorized signatory of the DD Form 1826 Pest Control Certificate of Competency for uniformed entomologists and preventive medicine technicians (PMT). NAVENTOCTR plays a key role in supporting national strategic interests though engagement and exchange with foreign health and military partners.

b. NAVENPVNTMEDUs provide operational services in the ashore, afloat, and expeditionary environments. NAVENPVNTMEDU entomologists provide force health protection through operational vector surveillance and control to enhance warfighter readiness. NAVENTOCTR also provides operational medical entomology and pest management training to DoD military and civilian personnel. NAVENPVNTMEDUs are home to the Forward Deployable Preventive Medicine Units (FDPMU) that have a disease vector component that can deploy with operational forces with an entire vector control equipment augment. There are four NAVENPVNTMEDUs and the operational areas of responsibilities are:

(1) NAVENPVNTMEDU TWO is located at Naval Station Norfolk, VA and provides support to U.S. Southern Command.

(2) NAVENPVNTMEDU FIVE is located at Naval Base San Diego, CA and provides support to U.S. Northern Command.

(3) NAVENPVNTMEDU SIX is located at Joint Base Pearl Harbor-Hickam, HI and provides support to U.S. Indo-Pacific Command.

(4) NAVENPVNTMEDU SEVEN is located at Naval Station Rota, Spain and provides support to U.S. European Command and U.S. Africa Command.

8-5. Specific Responsibilities of Applied Biologists of the Naval Facilities Engineering Command (NAVFACENGCOM). Specific responsibilities of applied biologists assigned to engineering field divisions of NAVFACENGCOM are delineated in reference (b).

8-6. Training and Additional Personnel

1. Shipboard Pest Management

a. Scheduled trainings for shipboard pest management are available to shipboard pest management personnel. Shipboard Pest Management Training (CANTRAC CIN: B-322-1075) presents techniques and precautions necessary to safely apply pesticides and manage pests aboard ship. All shipboard medical departments must have a senior enlisted medical department representative and all Corpsmen responsible for shipboard pest management certified in shipboard pest management in order to perform shipboard pest control procedures, per references (b), (e), and (f).

b. Only medical department personnel successfully completing the course may be officially certified. Certified personnel are qualified to procure standard stock pesticides approved for use aboard ship and conduct shipboard pest control operations. Other personnel, such as those in the supply and food service departments, play an important role in a ship's pest control program. These personnel are strongly encouraged to attend this training program though they are not authorized to provide pesticide applications.

c. Shipboard pest management certification is valid for 4 years from the date of certification. Certification is not required for medical personnel if the member is not assigned shipboard pest management duties on a vessel or at a shore station.

2. Pest Control at Shore Installations

a. Per reference (a), pesticide dispersal and other pest control operations must be performed by or under direct and continuing supervision of trained and certified personnel. Direct supervision includes being at the specific location where the work is conducted and maintaining line of sight view of the work being performed.

b. Training and certification of all DoD personnel must follow the guidelines in reference (e): "Pesticide Applicator Training and Certification Program."

c. Training and certification of medical department personnel assigned responsibilities related to surveillance and control of arthropods and other vectors must also follow the guidelines in reference (f).

d. Per reference (f), NAVENTOCTR and NAVENPVNTMEDU provide specialized vector and pest control training for certification and recertification. DoD (Category 8) Pesticide Applicator Recertification is available to PMTs. Shipboard Pest Management Certification and Recertification are available to Navy entomologists, PMTs, and Independent Duty Corpsmen.

8-7. Integrated Pest Control Programs and Pest Management. Reference (b) states that naval shore activities will cooperate with U.S. Federal, State, and local laws and comply with the official standards and criteria issued by such agencies. Navy ships in foreign harbors and naval installations overseas will adhere to Environmental Protection Agency (EPA) standards or those of the host nation (HN), whichever is more stringent.

SECTION II. PESTICIDES AND THEIR APPLICATION

8-8. Definitions of Pesticides

1. A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest; or any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

2. Pesticides are used in many ways and include acaricides, avicides, fungicides, herbicides, insecticides, molluscicides, nematocides, and rodenticides, among others.

8-9. Department of Defense (DoD) Standards

1. DoD components' pest management programs conform to the following requirements per reference (e). The DoD applicator or direct supervisor must be certified in the category appropriate for the work being performed. Contractor pesticide applicators must be certified in State or HN categories commensurate with the work to be performed or by specially trained site or shipboard medical department personnel. U.S. EPA restricted use pesticides may be procured and used only by certified pesticide applicators or by persons under their direct supervision.

2. Restricted and non-restricted use pesticides are procured through the military supply system. Where restricted or non-restricted use items do not provide satisfactory control, or when there is any doubt that available personnel are qualified to supervise the application of any pesticide, medical officers should request the help of specialists. Navy entomologists and applied biologists of NAVFACENGCOM will provide services necessary to survey pest problems, outline control programs, train, and certify local personnel.

3. Nonstandard pesticides and dispersal equipment must not be used unless procured per references (b), (g), and (h). Pesticides not on the shipboard authorized medical allowance list must be approved by and used under the direction of a NAVENPVNTMEDU uniformed entomologist and requires written waiver from the Type Command Force Surgeon. Non-EPA-registered pesticides will not be used in contingency locations without prior written approval of the Director, AFPMB. Requests for approval will include use justification, product label (in English or translated to English), active ingredients, manufacture location, safety data sheet (if available), and country-specific registration (if available).

8-10. Classifications of Pesticides

Pesticides may be classified on the basis of use, life stage of the pest to be controlled, chemical group, mode of entry, mode of action, and formulation. Some pesticides are not easily categorized by standard methods because they can be used against two or more groups of pests or in formulations that may have two or more modes of entry or action.

1. Pesticide Type by Use

   a. Acaricide. Substance used to control mites, scorpions, spiders, ticks, and related.

   b. Fungicide. Substance used to control fungi.

c. Herbicide. Substance used to control undesired vegetation.

d. Insecticide. Substance used to control insects; sometimes used in a broader sense to include the control of arthropods other than insects. Classification of insecticides may be subdivided on the basis of the life stage against which they are used:

(1) Adulticide. Used against the adult stage of an insect.

(2) Pupacide. Used against the pupal stage of an insect.

(3) Larvicide. Used against the larval stage of an insect.

(4) Ovicide. Used against the egg stage of an insect.

(5) Molluscicide. Substance used to control snails and other mollusks.

(6) Rodenticide. Substance used to control rodents.

2. Pesticide Type by Chemical Group

a. Inorganic Pesticides. Compounds of mineral origin; mainly includes boric acid, arsenic, copper, mercury, sulfur, or zinc. Mode of action varies on type of inorganic and include enzyme inhibition and desiccation.

b. Chlorinated Hydrocarbons. This group of insecticides are not longer authorized DoD insecticides.

c. Organophosphates. Synthetic compounds containing phosphorous that act as nerve agents, inhibiting acetylcholineserase. Some of the more common examples in this group are naled, dichlorvos, and malathion.

d. Carbamates. Synthetic compounds of salts or esters of carbamic acid that have a similar mode of action as organophosphates. Carbaryl and propoxur are examples.

e. Neonicotinoids**.** Pesticides that are chemically similar to nicotine. These pesticides act on the nervous system; insects are much more susceptible to them than mammals. Examples include imidacloprid and dinotefuron.

f. Botanicals. Pesticides of plant origin. Mode of action varies, but frequently targets the nervous system. Pyrethrum and rotenone are examples.

g. Pyrethroids. Synthetic versions of some botanical insecticides that act on sodium channels in the nervous system, causing a hyper-excitable state. These pesticides are effective against insects and extremely toxic to fish. Examples include permethrin, cyfluthrin, and lamda-cyhalothrin.

3. Pesticide Type by Mode of Entry

a. Stomach Poisons. Materials which kill following ingestion. Application may be directly to the pest's natural food, mixed with baits, or sprinkled in runways so pests will take the compound into the mouth when cleaning contaminated appendages.

b. Contact Poisons. These pesticides enter through the insect's body wall or respiratory system. They include residual surface sprays that kill pests coming in contact with the treated area and aerosols or space sprays that kill after contact with the body surface. Contact poisons may also act as a stomach poison if ingested.

4. Pesticide Type by Mode of Action

a. Biologicals. Pesticide formulations to control pests, containing parasitic microorganisms such as viruses, bacteria, fungi, protozoans, and nematodes, or containing their metabolic by-products. An example is *Bacillus thuringiensis* subspecies *israelensis* (Bti) granules or dunks.

b. Desiccants. Absorptive dusts that scratch, absorb, or abrade the waxy surface of the exoskeleton, causing death by dehydration. Silica gels are examples.

c. Repellents. Compounds that actively repel pests. Diethyltouamide (DEET), picardin, and IR3535 are examples.

d. Systemics. Compounds absorbed by and translocated throughout the host plant or animal to kill parasites sucking juice or body fluids, respectively. Herbicides may be systemic and kill the treated plant (root and aerial). Systemic insecticides may be topically applied or feed-through products for control of pests such as fleas.

e. Growth Regulators. Synthetic hormone-like compounds that prevent normal growth or maturity of the target plant or animal species. Insect growth regulators (IGR) are an example.

8-11. Pesticide Formulations and Dispersal

1. General. Some pesticide products can be applied in their concentrated form, or "neat," while other products may require dilution of the concentrate with oil or water. Dry dusts or granules are usually prepared in a ready-to-use form and require no further processing.

2. Formulation Selection. Selection of the proper formulation for a specific control measure is as important as the choice of pesticide. The formulations into which pesticides may be prepared include, but are not limited to:

a. Oil Solutions. Oil solutions consist of the toxicant mixed into a petroleum-based diluent. They are effective for penetrating cracks and crevices. Use oil solutions where dampness or water may cause problems or where there is a need to apply insecticides in cold weather. Apply as space aerosols or sprays either indoors or outdoors for knockdown or kill of insects. Space sprays are effective against flying insects only while the particles remain suspended in the air. Oil solutions are phytotoxic and care must be taken when using them around desired vegetation.

Oil solutions cannot be exposed to high temperatures or open flames, and their solvent action precludes their application to some synthetic substances (e.g., composition, fabric or plastic materials). Oil solutions are generally more readily absorbed through the skin and more odorous than other kinds of preparations.

b. Emulsions. An emulsion consists of a concentrate dispersed in a diluent in such a way as to prevent separation of the two components. Emulsifiable concentrates are almost always diluted with water, but can be diluted with oil to form an oil solution. "Breaking" the gradual separation of the water and other ingredients occurs with time, so the preparation must be used when freshly mixed. Occasional agitation may be necessary during use. Emulsions can be used on synthetic organic materials around heat or open flames. They must be used with care on vegetation as they can be phytotoxic.

c. Suspensions. Suspensions are even mixtures of small, solid particles dispersed in a liquid. Suspensions should be used with machines that provide constant agitation. If dispersed by a portable compressed sprayer, suspensions require frequent agitation. Suspensions are employed as residual treatments.

d. Dusts. A dust pesticide formulation is a mixture of a toxicant plus an inert base usually consisting of a finely ground form of bentonite, pyrophyllite, or talc. These mixtures are used as indoor and outdoor residuals and for animal applications. They are useful when venting in an application site is not feasible.

e. Granules and Pellets. Granules and pellets are preparations of pesticide impregnated into particles of highly absorptive clays or crushed shells, which are graded by sizes ranging from coarse pebble-like pellets to grains with a consistency of fine sand. Granules and pellets with greater particle weight have a minimal drift, preventing undesirable contamination of areas bordering those being treated. An important use of granules for vector control is in mosquito larviciding where penetration of foliage and adequate deposition in water is desired. Large turbine-type dusters, backpack units, hand-carried dust dispensers, and portable seeders can apply granules. Special aerial dispersal units may also be employed for large area treatment.

f. Other Pesticides. This grouping includes pesticides applied by brush or roller, as a paste, grease, or cream, or as solid formulations that vaporize slowly in air. Some solid formulations of pesticide compounds are used as baits.

3. Pesticide Dispersal. After the desired formulations have been selected, prepared, and procured, they may be dispersed in the following forms:

a. Aerosols. Aerosols are suspensions of particles in air. Particle size ranges from 0.1 to 50 microns in diameter, with 80 percent of the particles in the 0.1 to 30 micron range. Liquid particles form a fog and solid particles form a smoke. Insecticide aerosols are frequently dispensed from hand-held pressurized containers or larger ultra-low volume (ULV) dispersal equipment.

b. Mists. Mists are dispersed particles in which the particles are intermediate in size between those of aerosols and fine sprays. Droplets in the 50 to 100 micron size range are

considered to be mists. They are less effective than aerosols for outside space treatment, but they are adaptable for larviciding in areas accessible to vehicles and for large-scale residual spraying of vegetation. Because of their larger particle size, mists can be used under a wider range of weather conditions than aerosols, and their residual effect is greater.

c. Sprays

(1) Fine Sprays. Fine spray droplets are 100 to 400 microns in diameter. Droplets within this range remain airborne for short periods of time and settle rapidly. Sprays of this type are frequently used as mosquito larvicides and for residuals.

(2) Coarse Sprays. Coarse sprays consist of droplets over 400 microns in diameter and are applied evenly to wet a surface. Coarse sprays are frequently employed when applying herbicides and heavy residuals of insecticide to fly breeding areas.

8-12. Application of Pesticides

1. Effects of Particle Size. For efficient pesticide application, the proper dispersal of appropriate particle size is desired. Pesticides with residual qualities allow the pesticide to kill by contact long after the material has been applied to walls, vegetation, or other insect resting places. To take advantage of pesticide residual effects, apply pesticides only as directed by the application label. Effective use of space sprays requires dispersal in small particles. Under favorable conditions, space treatment with aerosols or fogs are efficient for killing insects or other arthropods. Unfavorable air currents or high wind velocity may cause atmospheric dispersal and drift to non-target areas, reducing space treatment efficiency.

2. Effects of Meteorological Conditions. There are many conditions which may improve or reduce the effectiveness of the pest control program. Meteorological conditions such as convection, relative humidity, wind velocity and direction, and temperature may add to the complexity of outdoor spray operations.

a. Convection. One of the most important factors influencing aerosol insecticide dispersal is convection, or the upward and downward movement of a limited portion of the atmosphere. Convection influences the deposition of particles on the surface of the ground, foliage, or target pest. When the ground temperature is at least one degree cooler than surrounding air (inversion), aerosol droplets tend to drift near the ground within the habitat where the target species is most likely to be contacted and can be carried by air currents. When the ground temperature is warmer than the air (lapse condition), aerosol and mist droplets tend to be carried up and out of the target zone by convection currents. Determine inversion or lapse conditions by measuring ground and air temperature using thermometers placed 0.3 and 1.8 meters (1 and 6 feet) above the ground.

b. Air Current. A fine spray or dust will be scattered over a very wide area during conditions of high winds, especially under lapse temperature conditions. On the other hand, a lack of air movement will limit pesticide distribution. It is advantageous to conduct outdoor space dispersal of aerosols if the movement of air is about 1 to 7 knots in a direction perpendicular to the line of dispersal (discharge from nozzle) and toward the area to be treated.

c. Temperature. Temperature may affect pesticide application in a variety of ways. Apply pesticides in temperature ranges as directed by the application label.

3. Selection of Method. Before a control operation is undertaken, determine if chemical control of the pest is the most satisfactory approach. Chemical control is the most expensive and least permanent of the various methods of pest control. It should only supplement, not replace, other pest control procedures. However, there are many situations where pesticides are valuable tools in the pest control program, such as during the threat of outbreak of vector-borne disease. Even during such times control personnel should not lose sight of long range and more permanent measures.

a. Preventive Control. Quarantine, drainage, impoundment, flushing, flooding, ditching, screening, sanitation, etc., are basic practices in the prevention of pest infestations. These methods of control are expensive initially, but over time are least costly and most effective. When military bases are of a permanent type, preventative control methods are preferred.

b. Chemical Control. This method of pest control is the most common and expensive and is temporary. In most field operations, when the site is to be occupied for short periods of time, chemical controls are used almost exclusively. Corrective controls are used until preventive controls are established, and then used only to augment more desirable methods of pest control. Under combat conditions, chemical control may be the method of choice because of the need to rapidly reduce the vector population and because permanent control measures may be impossible due to lack of security or equipment.

8-13. Resistance to Pesticides

1. Definition of Pesticide Resistance. Pest resistance to pesticides is the ability of a pest species population to withstand a poison that was effectively lethal to earlier generations of the species.

2. Development of Resistance. Populations of animal species include individuals that are susceptibility to pesticides. Consequently, candidate pesticides will kill some individuals of a species more readily than others. Individuals in a population that are less susceptible to a chemical control are considered to be more resistant. Continued pesticide pressure upon a population will destroy the most susceptible individuals, permitting the more resistant individuals to survive and produce generations of increasingly resistant offspring. Thus, the species becomes increasingly difficult to control because of genetic resistance factors transmissible to subsequent generations.

3. Prevention of Resistance. Selection of an insect population for insecticide resistance may be averted or delayed by rotating the different classes of insecticides available for control. For example, treating a mosquito population repeatedly with a pyrethroid insecticide may hasten the development of resistance to this class of insecticides; occasionally using a different class of pesticides, such as an organophosphate insecticide, can prevent development of resistance. The use of integrated pest management techniques, which include preventive, exclusion, biological, physical as well as chemical control methodologies together in a comprehensive pest control strategy, will also help to slow or stop the development of resistance.

SECTION III. PESTICIDE HAZARDS AND USE RESTRICTIONS

8-14. General

1. The information and directions on the pesticide label are important to every user. The information on the label discusses the chemical hazards, registered uses, recommended doses, compatibility, phytotoxicity, and legal restrictions. When properly followed, the directions provide maximal protection for applicators, consumers, and non-target organisms. Read all pesticide labels prior to use. Use of pesticides in a manner inconsistent with the label is a violation of Federal law (40 CFR Part 156).

2. Examples of information contained in the pesticide label include:

   a. Effects of human, animal, and environmental exposure.

   b. Composition of the formulated pesticide.

   c. Concentration of active ingredients in the formulated pesticide.

   d. Rate and methods of application required for control.

   e. Frequency of pesticide application.

   f. Storage and disposal instructions.

8-15. Assessment of Pesticide Hazards

1. When selecting a pesticide for a control program, possible hazards to animals other than the target pests must be considered. The physical and chemical properties of some pesticides may be toxic to other living organisms. Basic precautions must be practiced as all pesticides should be considered potentially harmful to humans to some degree. It is standard procedure to protect food, cooking utensils, and food preparation surfaces, and to avoid continued human exposure to pesticides.

2. When assessing the hazards of any particular pesticide, each of the listed factors in article 8-15, subparagraphs 2a through 2c must be carefully considered and evaluated:

   a. Oral and inhalation toxicity.

   b. Effect on the skin.

   c. Accumulative effect on body organs.

3. Continual awareness of hazards associated with pesticide handling and use, and careful attention to safeguards, make it possible to use all standard military pesticides with minimal risk.

4. Types of Pesticide Poisons

a. Stomach Poisons. Stomach poisons are pesticides ingested orally by the target pest. They are often formulated as block, granule, or gel that may contain a feeding attractant. Many substances used in stomach poisons to control insects and rodents are also toxic to man and non-target animals. Stomach poisons must be handled with care and used only in the amounts recommended for the specific pest. Stomach poisons are not to be used in any manner that is inconsistent with the directions on the label.

b. Contact Poisons. Contact poisons are pesticides that kill the target pest through direct, external contact. The degree of toxicity is related to the chemical and to the type of formulation. Many contact poisons are manufactured and marketed as a concentrate. Care must be exercised in handling, mixing, and using all contact poisons to avoid accidental inhalation, ingestion, or contact with the skin or eyes.

8-16. Toxicity of Pesticides

1. Pesticides can be toxic to humans and domesticated and wild animals at varying doses and must be used with care. Toxicity varies with the chemical nature of each pesticide and may be rated objectively as having low, moderate, or high toxicity. Before use, read and follow all safety and personal protective measure precautions for applications.

2. Toxicity Ratings. The data on acute oral, inhalation, and dermal toxicity divide pesticides into four groups (see Table 8-1 below). Toxicity is measured as lethal dose 50 (LD50) or lethal concentrations 50 (LC50), which indicate the amount of pesticide required to cause mortality in 50 percent of a test population. The group a pesticide is placed in is determined using the LD50 or LC50 that would classify it in the highest toxicity category. For example, a pesticide with an oral LD50 of 1,000 milligram (mg)/kilogram (kg), an inhalation LC50 of 25 mg/L, and a dermal LD50 of 500 mg/kg would be placed in the “Danger” category. These groupings have considerable practical value because packaging labels must include key signal words (e.g., DANGER, POISON, WARNING, and CAUTION), and, if applicable, antidotes and other necessary precautions.

Table 8-1. Criteria for Cataloging Pesticides by Toxicity and Label Requirements Established by the Amended Federal Insecticide, Fungicide and Rodenticide Act of 1972

Signal Word and Toxicity	Acute Oral LD_{50}	Acute Inhalation LC_{50}	Acute Dermal LD_{50}
I. "DANGER," "POISON," Skull and Crossbones - Highly Toxic	0-50 mg/kg	0-50 mg/L	0-200 mg/kg
II. "WARNING”- Moderately Toxic	50-500 mg/kg	0.2-2.0 mg/L	200-2,000 mg/kg
III. "CAUTION"- Slightly Toxic	500-5000 mg/kg	2-20 g/L	2,000-20,000 mg/kg
IV. *No Signal Word* - Almost Non-Toxic	5000 + mg/kg	20 + g/L	20,000 + mg/kg
Note. All pesticide products bear the words, "Keep out of reach of children."			

8-17. Insecticide Hazards and Use Restrictions

1. General. Insecticides formulated as solids or wettable powders and dusts pose less of a hazard by dermal poisoning than insecticides in solution. However, dusts and powders are easily inhaled and consequently produce a greater respiratory hazard. Regardless of toxicity, liquid concentrates used for contact or residual treatments must be handled with care and used only in the amounts recommended for the specific pest. Never use a pesticide in a manner inconsistent with its label.

2. Use Restrictions of Pesticides

a. Indoors. Residual pesticides with EPA registration for use in food preparation areas are limited to crack and crevice treatment. Do not use these materials in occupied spaces and do not permit entry to an area prior to proper ventilation. Small amounts of pesticides are applied directly into natural and constructed cracks and crevices; between equipment bases and floors; into wall voids, motor housings, junction or switch boxes; inside conduits or hollow equipment legs; and into any other place where pests may hide. In non-food areas these pesticides may be applied by spray or brush to floors, walls, ceilings, or other infested areas. Overall treatment of interior surfaces of occupied spaces is prohibited. No person should be allowed to contact treated surfaces until the liquid residual dries.

b. Outdoors. As directed by the label, do not allow pesticides to enter any body of water directly or as runoff as most pesticides are toxic to aquatic life. Do not use these chemicals on food or forage plants or on animals in a manner other than that recommended on the label. Avoid drift of sprays or dusts and keep domestic animals from contact with wet treated surfaces. Restrict application of these pesticides to infested areas.

8-18. Rodenticide Hazards and Use Restrictions

1. General. To prevent rodenticide from being accessible to children, pets, or domestic animals, it must be placed in tamper-proof boxes. Baits should be picked up and disposed of upon completion of the control program. Bait stations should be checked monthly unless rodent activity is noted, in which case they should be checked at least weekly.

2. Anticoagulant Baits. All standard pesticide precautions apply when handling single or multiple dose anticoagulant materials.

SECTION IV. PRECAUTIONS IN HANDLING PESTICIDES

8-19. General. The precautions listed in this section will enable individuals to use, store, mix, and dispose of pesticides and rinse solutions in a manner safe to themselves, other personnel and the environment. The user of pesticides is charged with the responsibility of knowing and complying with current EPA regulations and DoD and Navy policy.

8-20. Personal Protective Equipment (PPE). PPE and clothing must be worn to protect all parts of the body from pesticide contamination and must be stored in an area separate from any pesticide exposure. Always read the pesticide label for recommendations on the use of protective clothing and devices.

1. Respiratory Protective Devices

a. Wearing a National Institute of Occupational Safety and Health approved respiratory device is necessary when there is any risk of inhalation of pesticides and indicated on the pesticide label.

b. Specific types of cartridges and canisters protect against specific gases and vapors. For low concentrations of insecticide sprays, dusts, mists, and vapors, use an approved respirator with an organic vapor cartridge.

c. Check the respirator's flutter valve to ensure proper functioning.

d. Change respirator cartridges after 8 hours of use, or sooner if pesticide odor is detected. During heavy spraying, change respirator filters every 4 hours. After use, remove the filters and cartridges, wash the face piece with soap and water, rinse and dry it with a clean cloth, and store it in a clean, dry place, preferably in a tightly closed paper or plastic bag away from pesticides and pesticide equipment.

2. Eye Protection. Wear unvented or indirect vented goggles or a face shield to prevent contamination of the eyes with pesticides. After use, wash goggles with soap and water, rinse and dry with a clean cloth, and store with the respirator.

3. Body Protection. Wear protective clothing as indicated on the pesticide label. When mixing pesticides wear a nonabsorbent apron and chemical proof gloves.

a. Wear trousers on the outside of lightweight rubber boots to prevent pesticides from getting inside the boots.

b. Wear a clean set of clothing daily. If fabrics get wet during operation, change immediately. Wash contaminated clothing separate from other clothing. Do not take protective clothing home to be laundered. Laundering facilities should be provided.

4. Head Protection. Always wear something to protect the head. Pest control operators usually wear hard hats. When there is a possibility of drift, wear a wide brimmed, waterproof hat to protect neck, eyes, mouth, and face.

5. Hand Protection. When handling and mixing concentrated pesticides, wear liquid-proof, solvent resistant gloves (e.g., rubber, neoprene, or nitrile). They should be long enough to protect the wrist. Gloves should not be fabric lined as they are hard to clean if contaminated. Never use gloves of an absorbent material because they do not provide adequate protection. Position garment sleeves outside of the gloves to keep pesticides from running into the gloves. Wash gloves daily and test for leaks by filling them with water and gently squeezing.

6. Ear Protection. Ear protection is important during use of large pesticide dispersal equipment. Earmuffs provide maximum sound protection. It is extremely important that ear protective devices, whether plugs or muffs, be cleaned after use.

8-21. Pesticide Formulation, Storage, Fire Protection, and Transportation

1. Formulation of pesticides must be done in areas separate from office and locker spaces. Formulation areas should be equipped with ventilation, adequate lighting, and washing and shower facilities.

a. The pesticide handling area must be able to contain spilled pesticides and rinse solutions to prevent environmental contamination. There should be no drains in the floor that lead to the municipal sewage system.

b. Put on the correct protective equipment and clothing before handling any pesticide container.

c. Carefully read the entire label each time before removing the pesticide from the container.

d. Always formulate in the specially designed area and keep the pesticide container below eye level to avoid a splash or spill onto goggles. Use a sharp tool to open paper containers; do not tear them open.

e. Use only the amount specified on the label.

f. Post written safety procedures to be followed in the case of pesticide spills. These procedures should include the medical department's telephone number and the location of decontamination materials.

g. If the user becomes contaminated with pesticide, stop immediately and remove the contaminated clothing. Wash the exposed area thoroughly with soap and water. Speed is important because of the rapid absorption rate of pesticides by the body (15 minutes or less).

h. After use, replace all pour caps and reseal bags and other containers to prevent spills and cross contamination.

2. Store Pesticides following the product label

a. Maintain a current listing of all pesticides in storage and keep the list readily available for emergency use. This list should also be maintained as an appendix to the activity pest management plan, with a copy filed with the activity's medical and fire departments. The list should include article 8-21, subparagraphs 2a(1) through 2a(10) information:

(1) Manufacturer or distributor.

(2) Chemical name or group (e.g., organophosphate).

(3) Concentration.

(4) Type of formulation (e.g., oil solution, dust).

(5) Toxicity.

(6) Quantity.

(7) Flashpoint.

(8) Type of container (e.g., glass, drum).

(9) Common or brand name of pesticide

(10) EPA registration number

b. Storage areas must allow the pesticides to be kept dry, cool, and out of direct sunlight to avoid deterioration. They should be insulated to prevent the chemicals from freezing or exposure to temperatures in excess of 100ºF.

c. Storage areas should be of fire-resistant construction with a concrete floor and good lighting. The exhaust air ventilation system should provide at least six fresh air changes per hour. This ventilation system need only operate when the storage and formulation areas are occupied. A light and exhaust switch with a pilot light should be located outside the door and marked with a sign reading, "OPERATE VENTILATION SYSTEM DURING OCCUPANCY."

d. Storage areas should be liquid tight with a raised sill or a floor at least 10.2 centimeters (4 inches) below the surrounding floor. Openings must have approved self-closing fire doors.

e. Security personnel should be informed of potential hazards in the pesticide storage area.

f. Storage areas should have washing and firefighting capabilities and containment and decontaminating kits.

g. As soon as pesticides are delivered, mark the date of receipt on the container. Store in a locked and posted facility away from unauthorized individuals. Keep storage entrances locked when trained personnel are not present.

(1) Maintain a clear aisle of at least 0.9 m (3 feet).

(2) Do not stack containers of flammable or combustible material over 114 liters (L) (30 gallon) in size upon each other.

(3) Dispense by pump or self-closing faucet devices bearing manufacturer's laboratory tested approval.

(4) Have safe, clearly marked, unobstructed exits in storage areas.

h. Do not store fertilizers and pesticides in the same building because of a difference in applicable fire control methods.

i. Store all pesticides in the original containers where the label is plainly visible. Never put pesticides in another container unless the original has deteriorated. If repackaging is necessary, ensure identical labeling of the new container. Dispose of deteriorated containers properly (article 8-23). Never store herbicides with other classes of pesticides. Pesticides contaminated by volatile herbicides can cause unintentional damage to lawns and plants. Also, periodically check all pesticide containers for leaks or breaks and clean up any spilled material from damaged containers and repackage the contents.

3. Fire protection in the shop area generally can be accomplished with portable fire extinguishers. Contact the fire department for assistance.

a. Smoking is never permitted in a pesticide handling area. Appropriate warning signs should be posted and enforced.

b. It is important to inventory the amounts and types of flammable and combustible liquids in each area. Combustible liquids are those with flash points greater than 37.8ºC (100ºF) and flammable liquids are those with flash points below 37.8ºC (100ºF). These liquids must be stored in proper containers. Cases, boxes, or proper shelving must protect breakable containers.

c. In pest control shops the potential for class A, B, or C fires exists. Therefore, it is recommended that pesticide storage and formulation areas have multi-rated fire extinguishers.

d. The number of fire extinguishers needed to protect a shop is based on several factors. Usually, at least one in the storage and mixing area and one in the general shop area are sufficient. The maximum allowable distance permitted for travel to an accessible fire extinguisher for flammable liquids is approximately 15 meters (50 feet).

e. Fire extinguishers should be conspicuously marked and located where readily observed and immediately available for use.

f. Special fire hazards created by pesticides include toxic fumes from volatized chemicals, accidental contamination of firemen, potential explosion of combustible pesticides or their solvents, and environmental contamination from runoff water if used for fire control.

4. Transportation of Pesticides

a. The user of pesticides is legally responsible for their safe transportation after purchase and possession.

b. Carry pesticides in the back of a truck, never in the cab. They should be securely fastened, enclosed, and locked to prevent spillage and contamination of personnel and equipment. Do not use vans as pest control vehicles.

c. Allow special precautions for paper containers to protect them from moisture damage.

d. Secure signs properly on the vehicle to warn of the potential hazard.

e. If any pesticide is spilled in or from the vehicle, clean up the spillage as discussed in article 8-22.

f. Pest control vehicles must carry a small spill clean-up kit and a container of eye wash solution.

8-22. Decontamination of Equipment and Pesticide Spills

1. Decontamination is removal of the toxicant to a disposal area. It is not neutralization. Pesticide spill kits should be located at every pesticide storage facility. Refer to reference (k) for additional information. Keep the amount of cleaning solution used for decontamination to a minimum because it must be disposed of in the same manner as waste pesticides.

2. The first step in decontamination of an area or piece of equipment from a minor spill is to confine the pesticide. If the chemical starts to spread, contain it with dikes of sand or dirt. For dry pesticide spills, clean up the agent and treat the contaminated surface as directed in the listed article 8-22, subparagraphs 2a through 2e.

a. Use an absorbent material, such as fine sawdust or other specially designed material, to soak up the spilled liquid pesticide.

b. Shovel all contaminated material into a leak-proof barrel for disposal.

c. Do not flush the contaminated area. Treat contaminated surfaces with detergent and water or chlorine bleach. The latter solution may be used on all groups of pesticides except organochlorines. With a long-handled broom and decontamination solution, thoroughly scrub the exposed surface.

d. Soak up the decontamination solution with absorbent material and place it in a leak proof barrel for disposal.

e. Repeat the washing and collection procedure of steps in article 8-22, subparagraphs 2c and 2d until all of the pesticide is removed.

3. For major spills, follow the same procedure listed in article 8-22, subparagraphs 2a through 2e, and then call the medical department, base environmental, or area entomologist for specific instructions and assistance.

a. If a major spill occurs on a highway, notify the highway patrol or local sheriff.

b. Do not leave the area until responsible assistance arrives and have been appraised of the dangers involved.

4. Designate all movable equipment used for handling pesticides and pesticide containers as pest control equipment and do not remove them from working areas unless thoroughly decontaminated.

a. Wear appropriate protective clothing during the equipment cleaning process.

b. Clean equipment with detergent and water solution or spray lime [1.4 kg (3 lbs.) in 18.9 L (5 gallons) of water]. Where legal, dispose of cleaning and rinse solution in a sanitary sewer system according to EPA regulations.

8-23. Pesticide and Container Disposal

1. Dispose of pesticides only if the products are contaminated, outdated, no longer needed, or cannot be used at another activity.

2. Contact your regional Defense Reutilization and Marketing Office of the Defense Logistics Agency for specific details on pesticide disposal.

SECTION V. FIRST AID AND EMERGENCY TREATMENT FOR PESTICIDE EXPOSURE

8-24. General Procedures

1. Strict adherence to basic principles in rendering first aid to victims of pesticide contamination and poisoning may avert disfigurement, compromise of health, and possibly loss of life. Instructions for emergency medical treatment for acute pesticide poisoning should be posted in conspicuous places where pesticides are stored, issued, mixed, or handled.

2. Decontamination is extremely important in pesticide poisoning and should be done as quickly and thoroughly as possible. When properly accomplished decontamination terminates exposure, thereby limiting the risk of adverse effects.

3. Prior to any pesticide application, the medical department should be given a copy of the pesticide's Safety Data Sheet. This ensures that proper treatment is given in the event of human exposure.

4. Supportive therapy does not counteract the specific toxic action of the pesticide, but assists in maintaining vital body functions. The purpose of supportive therapy is to keep the patient alive until specific antidotes can be given and take effect, or until the body has sufficient time to metabolize and detoxify the poison. Supportive therapy includes the following:

   a. Cardiopulmonary resuscitation.

   b. Artificial respiration (mouth to mouth if oral intake of the pesticide is not involved).

   c. Maintenance of a clear airway.

   d. Oxygen therapy for cyanosis.

   e. Postural drainage.

5. A nation-wide network of poison control centers has been established in conjunction with the U.S. Public Health Service (PHS). These centers are usually located in local hospitals and are geographically located to be available by telephone from almost every part of the country. Their staff members are specially trained for the treatment of poison cases. When requiring information and assistance, dial the number given for the poison control center in the nearest city.

8-25. First Aid for Pesticide Contamination

1. Eye Contamination

   a. Holding the eyelids apart, wash the eye for 15 minutes with a gentle stream of running water from the bridge of the nose downward. If using eyewash station, ensure water is cool before application.

   b. Do not use chemical antidotes or soaps because they may further injure the eye.

2. Skin Contamination

a. Flood the skin with water.

b. Direct a stream of water onto the contaminated area while removing the patient's clothing.

c. Wash skin and hair thoroughly with soap and water. Do not use chemical antidotes unless directed by a physician.

8-26. First Aid for Internal Poisoning From Pesticides. In the event of ingestion causing internal pesticide poisoning, render first aid as listed here:

1. When possible, obtain immediate, on-the-spot services of a physician or contact a poison control center. If this is not possible, deliver the first aid recommended on the label of the pesticide container, then rush the victim to the nearest medical facility. Do not induce vomiting unless directed by the label, and never attempt to administer an oral antidote to an unconscious victim.

2. In the event no specific first aid procedures are recommended on the label of the pesticide container, administer the treatment as recommended on Safety Data Sheet until the services of a physician are available.

3. If the victim is cold, cover them with a light blanket.

4. In the event the victim stops breathing or breathing becomes difficult, administer the appropriate artificial respiration.

8-27. Organophosphorus Pesticide Poisoning and Suggestions for Treatment. Organophosphate pesticides cause irreversible cholinesterase inhibition. Examples of organophosphate pesticides include: dichlorvos, malathion, and naled.

1. Signs and Symptoms

a. Mild. Headache, dizziness, weakness, anxiety, pupillary contraction, blurred vision, and nausea.

b. Moderate. Nausea, salivation, lacrimation, abdominal cramps, diarrhea, vomiting, sweating, slow pulse, muscular tremors, and respiratory compromise.

c. Severe. Respiratory difficulty, pinpoint and non-reactive pupils, pulmonary edema, cyanosis, loss of sphincter control, muscle spasms, convulsion, coma, and eventual death due to respiratory failure.

2. Antidotes. In the event of an organophosphorus pesticide poisoning immediately call a poison control center and seek medical treatment for antidote administration.

8-28. Carbamate Pesticide Poisoning and Suggestions for Treatment. Commonly used pesticides that exhibit reversible cholinesterase inhibition include carbaryl, fenoxycarb, and methomyl.

1. Signs and Symptoms. Signs and symptoms of poisoning include pupillary constriction, salivation, profuse sweating, lassitude, loss of muscle coordination, nausea, vomiting, diarrhea, epigastric pain, and tightness in chest.

2. Antidotes. In the event of a carbamate pesticide poisoning immediately call a poison control center and seek medical treatment for antidote administration.

Note. Pralidoxime Chloride or Protopam Chloride (2-PAM) is contraindicated in carbamate insecticide poisoning. Also avoid aminophylline, barbiturates morphine, phenothiazine, tranquilizers, and theophylline.

8-29. Organochlorine Pesticide Poisoning and Suggestions for Treatment. Though no longer used in DoD or the United States., this information is provided in the case of exposure in operational environment. Organochlorine pesticides are central nervous system depressant and stimulants. They include benzene hexachloride, chlordane, Dichloro-diphenyl trichloroethane (DDT), dieldrin, heptachlor, and lindane. The exact mode of actions of these chemicals is not known. In general, they act on the central nervous system to stimulate or depress, carrying by compound. Repeated doses may affect liver and kidney functions.

1. Signs and Symptoms. Within 20 minutes to 4 hours, the following may occur: headache, nausea, vomiting, restlessness, tremor, apprehension, convulsions, coma, respiratory failure, and death. Do not induce vomiting if the ingested poison is principally an organic solvent (e.g., kerosene).

2. Treatment. In the event of an organochlorine pesticide poisoning immediately call a poison control center and seek medical treatment.

8-30. Mosquitoes

1. General Characteristics. Mosquitoes are in the fly family and develop by complete metamorphosis through four stages: egg, larva, pupa, and adult. The number of days from egg to adult varies. The egg, larva, and pupa stages must develop in water. Mosquitoes oviposit on the surface of water or on surfaces subject to flooding. Larvae hatch and feed on organic matter in the water, but must come to the surface for air. The larval period includes four developmental instars (growth stages) usually requiring 5 to 15 days to complete. At the end of each instar the larva molts (sheds its skin). The fourth instar molt is the last larval stage before transitioning to a pupal form. The mosquito pupa does not feed but is very active and must come to the surface for air. The pupa differs greatly from the larva in shape and appearance. The front part of the pupa, consisting of the head and thorax, is greatly enlarged and enclosed in a sheath that is lighter than water. On its upper surface is a pair of respiratory tubes. The pupal stage lasts from 1 day to a few weeks. The adult mosquito is a small, fragile insect with a slender abdomen, one pair of narrow wings, and three pairs of long, slender legs. The adult varies in length from slightly over 1/16 to 1/2 of an inch. Its three body regions - head, thorax, and abdomen - are well defined.

a. Mosquitoes use a great variety of water sources for breeding, including ground pools, water in artificial containers, water-holding tree holes, crab holes, and leaf axils. Adults rest in concealed places when not actively seeking food. Only adult females feed on blood. The distance of dispersal from breeding areas varies from a few meters to many kilometers, depending on species involved. Males normally do not fly long distances from breeding areas; any uncommonly large concentration of males usually indicates that a breeding area is near.

b. Mosquitoes rank first in importance among the insects that transmit diseases to man. This is partially because biting habits vary among genera and species regarding habitat, time of day, and host type and availability. This variability causes exposure to and subsequent transmission of different disease organisms (e.g., periodic, and non-periodic filariasis). The genera most frequently associated with disease transmission are *Aedes*, *Anopheles*, and *Culex* (see Figure 01, Appendix B). Disease organisms vectored by mosquitoes to man include bacteria (tularemia), arboviruses (dengue, encephalomyelitis (Eastern, Western, St. Louis, West Nile, Japanese B, and Russian Spring-Summer), and yellow fever), protozoa (malaria), and filarial nematodes. Besides serving as disease vectors, many species of mosquitoes are serious pests of man solely because of their irritating bites.

2. Medically Important Mosquitoes

a. *Anopheles* species (spp)

(1) Biology. *Anopheles* mosquitoes lay their eggs singly and horizontal on the water surface. Eggs are elongated ovals averaging about one-half millimeter in length, with a point at one end and a pair of lateral floats. Hatching usually takes place within 2 or 3 days. Larvae lie parallel to the water surface as *Anopheles* larvae have no breathing tube. Adult *Anopheles* mosquitoes are distinguishable from other mosquitoes by palpi as long as their proboscis, and tend to rest with their abdomens at a 40 to 90-degree angle to surfaces.

(2) Medical Importance. *Anopheles* mosquitoes are the primary vector for the malaria parasite.

b. *Culex* spp

(1) Biology. *Culex* mosquitoes lay their eggs side by side to form a raft that often contains 100 eggs or more. Eggs remain afloat on the surface of the water until hatching, usually within a few days. Larvae hang head down with only the tip of the air tube penetrating the surface.

(2) Medical Importance. *Culex* mosquitoes are the primary vectors of most encephalitide diseases including West Nile virus, St. Louis encephalitis, Japanese encephalitis, Western Equine encephalitis, and Eastern Equine encephalitis.

c. *Aedes* spp

(1) Biology. *Aedes* mosquitoes lay their eggs singly on the sides of container or tree hole interiors just above the water level; when the water rises, the eggs hatch. Some *Aedes* species may survive in the egg stage for 3 to 5 years if flooding does not occur. In some cases hatching occurs as soon as the eggs are flooded; thus, several generations per year may occur. Like *Culex* mosquitoes, *Aedes* larvae hang head down with only the tip of the air tube penetrating the water surface. Adult *Aedes* mosquitoes have a pointed abdomen, in contrast to *Culex* which have blunt-ended abdomens.

(2) Medical Importance. *Aedes* mosquitoes are the primary vectors for dengue virus, chikungunya virus, yellow fever virus, Zika virus, and La Crosse virus.

3. Less Medically Important Species

a. Although the "Big Three" genera of *Aedes, Anopheles,* and *Culex* represent the majority of mosquito vectors of human disease, many species of mosquito in other genera bite humans and transmit disease.

b. *Mansonia* spp

(1) Biology. *Mansonia* mosquitoes differ from other mosquitoes in laying their eggs in clusters on the undersides of the leaves of certain aquatic plants such as water lettuce (*Pistia stratiotes*); larvae breathe by attaching their siphons to the roots of these plants. This behavior protects them from control techniques that work by smothering mosquito larvae, such as surface films; remove host plants to effect larval control. *Mansonia* adults look superficially similar to *Culex* adults but are distinguished by uneven wing scales creating splotchy, light-and-dark wing patterns.

(2) Medical Importance. *Mansonia* mosquitoes are the major vectors of lymphatic filariasis in Southeast Asia and are important vectors of many viruses in Africa and Asia.

4. Surveillance

a. Mosquito Larvae Surveillance. Collect mosquito larvae to determine species involved, breeding sites, and relative abundance. Tools used in collecting larvae include a long-handled white enamel dipper, a large mouth pipette, a piece of rubber tubing several feet long, a suction bulb, screw cap vials, pencil, paper, a flat white porcelain pan, and 70 percent ethanol (ETOH).

b. Collecting Techniques Vary with Species Involved. For free-living species approach the breeding site carefully, as larvae are sensitive to vibrations and shadows. For Anopheline species skim the surface of the water with the dipper. Culicine species are more active; a quick dipping motion with the dipper provides the best results. For a control program, establish regular larval dipping stations so the average number of larvae per dip can be used as an index of control effectiveness. Collect container, tree hole, crab hole, and leaf axil breeders with a pipette or aspirate with a suction bulb attached to a piece of rubber tubing. Collect *Mansonia* and *Coquillettidia* larvae by pulling up aquatic vegetation (sedges, cattail, etc.) and rising the vegetation in a pail of water. Larvae drop off plants quickly, so it may be productive to scoop up samples of bottom sediment with a bucket and rinse the material with a strainer. Transfer the rinse and strained water in small amounts to a small porcelain pan and examine it closely for larvae.

c. Mosquito Adult Surveillance. Collecting adult mosquitos requires consideration of the species' behavior. As no single method attracts all species, a combination of methods is desirable.

(1) Light traps. Light traps attract phototrophic species. The New Jersey light trap is widely used for this purpose. It is an open metal cylinder protected by a conical cover. A 25- to 40-watt white light attracts insects, which are then drawn by an electric fan into a collecting jar containing a piece of dichlorvos-treated resin strip or paradichlorobenzene. A perforated paper cup suspended from the rim of the jar keeps the mosquitoes dry, clean, and easy to remove. The fan requires 110 volts and can be turned on and off by an electric timer or photo-electric cell.

(a) Another type of light trap is the Centers for Disease Control and Prevention (CDC) or solid-state Army miniature light trap. It weighs about 0.8 kg (1/3 lb) and operates on any 6 volt DC source. Use of a 30-amps/hour-motorcycle battery provides up to 5 nights' operation without recharging. Live adults are collected in a cage of nylon netting and can be used in virus isolation studies.

(b) Proper trap placement is especially important. Place the traps about 1.5 to 1.8 meters (5 to 6 feet) above the ground and avoid competing light sources, windy areas, and industrial fumes. Avoid trapping in livestock and bird roosting areas, as mosquitoes are less easily attracted to light after taking a blood meal. Optimal results are obtained in areas with adequate vegetation and high humidity. A shift of a few meters (between 9 and 15 feet) can make a substantial difference in results; if trapping results are poor, change the trap locations before reporting the absence of mosquitoes in the area. In addition to indicating species present, trapping signals proportions of male to female adults. Males emerge before females and congregate near breeding sites; detecting an increase of males allows treatment of a population before a major increase in the number of adult females occurs, lowering breeding potential.

(2) Resting Stations. For Anopheline species not strongly attracted to lights, collect at resting sites by sweeping vegetation with an insect net or by using an aspirator and a flashlight. Aspirators are made of rubber or plastic tubing joined to a piece of rigid clear plastic tubing [0.9 centimeter (0.37 inch) inside diameter] with a piece of netting in between the two tubes for a filter. Check cool, dark, and humid areas, including culverts, bridges, caves, overhanging stream banks, wells, and buildings. Artificial devices such as boxes, barrels, and kegs can be established in areas with few resting sites. Resting boxes, which serve as artificial resting sites for mosquitoes, may also be deployed. The interior of these resting boxes may be painted red or some other dark color, as dark colors seem to be attractive to certain species of mosquitoes. The size of the resting box is not critical although square units (12 x 12 inches) may be more manageable. Boxes should be large enough for mosquitoes to easily see, and large enough for an aspirator or other collection device to be introduced into the box. For a detailed discussion of mosquito collection, a "Mosquito Surveillance Guide" is available from NAVENPVNTMEDUs and NAVENTOCTR.

(a) BG Sentinel Traps. This trap mimics convection currents created by the human body and releases artificial skin emanations over a large surface area. The BG Sentinel trap can be used in combination with the BG-Lure, a dispenser which releases a combination of non-toxic substances found on human skin (ammonia, lactic acid, and caproic acid). Using the trap together with the lure makes it especially attractive to *Aedes aegypti*, *Ae. albopictus*, *Culex quinquefasciatus*, and selected other species. It is an excellent general mosquito trap when used with CO_2 but can be used successfully without carbon dioxide.

(b) Gravid Traps. The gravid trap is designed primarily to collect gravid *Culex* spp mosquitoes. It consists of a trap body with electric fan, collection container, and oviposition bucket or pan. The trap operates on a 6 volt gel-cell battery. Attract mosquitoes by placing organically rich water infusions made with aged hay, sod, dead vegetation, or livestock feces in the bottom of the pan, approximately 1 inch below the opening of the trap entrance. Female mosquitoes attracted to the water as a place to oviposit are drawn into the collection bag by the trap's fan. Gravid traps collect mostly females ready to lay eggs; the female mosquitoes are also likely to have taken a recent blood meal, so a higher proportion of mosquitoes from gravid trap collections will be infected with arboviruses or other pathogens if present in the area. As a result, gravid traps offer an ideal collection tool for capturing adult female *Culex* spp. for virus screening.

5. Control

a. Control of Immature Stages. Treat water surfaces with larvicides to temporarily control mosquitoes.

(1) Ground Larviciding. Where no larval resistance to insecticides has been documented, solutions, emulsifiable concentrates, granules, and water-dispersible powders may be used with ground-operated equipment. Use granules where heavy vegetation covers must be penetrated or where possible damage to crops (e.g., rice) is a consideration. Because the percentage of toxicant and application rate vary with type of equipment used, species of mosquito involved, geographical area considered, and degree of resistance developed, current recommendations should be obtained from appropriate technical personnel (see articles 8-4 and 8-5).

(2) Aerial Larviciding. Per reference (b), aerial application of pesticides may be required by the Navy to control such pests as disease vectors, forest pests, and invasive weeds. Reference (a) recognizes aerial pesticide application as a specialized pest management operation. Special care is required due to the highly technical nature of the equipment used, potential for area-wide contamination, and potential liability. Aerial dispersal must be performed only after the responsible action proponent has carefully evaluated the risks and benefits consistent with reference (i) and consulted with the responsible NAVFACENGCOM National Environmental Policy Act (NEPA) lead to determine environmental documentation requirements. Aerial spray applications must be coordinated with the appropriate Federal, State, or local authorities to ensure that applicable permits, approvals, and certifications are obtained. The responsible pest management consultant, DoD-certified in EPA aerial application category 11, must review and approve project aerial application validation statements. Aerial operations involving suppression of potential disease vectors must be validated and coordinated by the responsible Bureau of Medicine and Surgery (BUMED) pest management consultant. Other operations shall be validated and coordinated by the responsible NAVFACENGCOM pest management consultant. Approvals must be obtained before applications commence.

(a) Where permanent control measures (e.g., drainage, filling) cannot be accomplished economically.

(b) Where there is no access to ground dispersal equipment.

(c) Where screening, repellents, space sprays, and residual treatments are not adequate to control vector borne diseases or to increase work efficiency.

(d) Where ground application of aerosols, mist, or other insecticidal formulations are ineffective in reducing or controlling heavy populations.

(e) Where it is economically more practical to treat a major breeding area with aircraft rather than ground control equipment.

(3) Control in Water Containers. Eliminate containers in which mosquito larvae may thrive, such as empty cans and old tires, if possible. Treat those that cannot be eliminated with a larvicide to control and prevent breeding.

b Control of Adult Mosquitoes. Control adult mosquitoes by the application of residual and space sprays.

(1) Indoor Control. Space sprays are recommended for interior control of mosquitoes when immediate eradication is required. Space sprays can be effectively applied with an aerosol dispenser. Treatment with the standard aerosol dispenser should be at a rate indicated by the insecticide label. Space sprays have little or no residual effect and must be reapplied whenever new mosquitoes enter the space.

(2) Where frequent re-entry is a problem or where disease bearing mosquito species are involved, apply residual sprays to the surfaces where mosquitoes are likely to rest. Residual sprays differ from space sprays principally in possessing a greater concentration of the toxicant material. Only insecticides with long-lasting effects are suitable for use in residual sprays.

Where rough, absorbent surfaces are involved, the use of a suspension made by mixing a water-dispersible powder is more effective than the use of either a solution or emulsion. When resistance to an insecticide is suspected, contact the nearest entomologist for assistance or advice. Equipment required for residual and space applications is described in Section VIII.

(3) Outdoor Control. ULV and thermal fogging is recommended for the outdoor control of adult mosquitoes. ULV or fogging application often provide control within a limited region and bring adequate protection for short periods. However, in any area where reproduction is continuous the use of ULV or fogging alone is only satisfactory if done on a repetitive basis.

(a) ULV and thermal fogging. Operations should be accomplished when wind speeds are less than 6 knots and when a temperature inversion is present. Since ULV and fogging applications are most effective against flying insects, they should be accomplished when the target species are active.

(b) Residual sprays. Residual sprays have a limited exterior applicability for the protection of small camps. When used, the spray is applied to all vegetation surfaces for an area of 30 meters or more around the place to be protected, and to insect resting places around populated areas.

c. Protective Measures

(1) Screening. Protect living quarters in permanent or semi-permanent camps with 18-mesh screening. Use bed nets as additional protection where vector species are present.

(2) Personal Protection. Personal application type insect repellents are discussed in article 8-32.

(3) Camp Location. In areas where disease-bearing mosquitoes occur, zones outside the camp perimeter should be off-limits to all military personnel, except as required. Locate camps as far as possible from native villages to avoid contact with potentially infected mosquitoes.

(4) Chemoprophylaxis. Administration of chemo prophylactic drugs as prescribed by medical personnel are essential in malaria endemic areas as a supplement to vector control.

8-31. Other Flies

1. General Characteristics. All flies develop by complete metamorphosis: egg, larva, pupa, adult. All flies exhibit a single pair of wings, a pair of small halteres in place of a second set of wings, a mobile head, and large compound eyes. Mouthparts vary significantly between fly families. Medical concerns for flies range from general nuisance to transmission of deadly pathogens.

2. Filth Flies

a. House Fly (*Musca domestica*)

(1) Biology. House flies lay eggs in decaying vegetable and animal matter such as garbage, latrines, animal manure, spilled animal food, and soil contaminated with organic matter. Its eggs are deposited in decaying vegetable and animal matter such as garbage, contents of pit latrines, animal manure, spilled animal food, and soil contaminated with organic matter. The female may lay as many as 20 batches of eggs at 3- to-4-day intervals. Under favorable conditions the eggs hatch in 8 to 12 hours. The mobile larvae (maggots) are creamy white and grow to about 0.5 inch length. This developmental stage varies from 3 to 24 days but is typically 4 to 7 days in warm weather. The larval stage ends when the larvae burrow into the soil or debris and become covered in a brown pupal case. The pupal stage usually lasts 4 to 5 days but under very warm conditions may only require 3 days. When metamorphosis is complete, the adult crawls out of the puparium to the surface where it expands its wings, and flies away. Mating occurs 1 to 2 days after pupal emergence. The adult is gray in color with a gray thorax marked by four equally broad, dark longitudinal stripes. The mouthparts are non-biting and adapted to sponging.

(a) House flies use a wide variety of material for food including organic filth, human foodstuffs, and agricultural waste. Because they can take only liquefied foods, they moisten substances with a "vomit drop." This drop of fluid, often teeming with microorganisms, dissolves solid materials to be used as food. This fluid food is sponged up. This feeding method, combined with the habit of walking over organic filth, accounts for the ease that they transmit disease organisms to food, and cooking and eating utensils. The "fly speck" vomitus (light colored) and fecal discharge (dark colored) both serve as sources of contamination.

(b) When inactive, flies tend to congregate in certain preferred resting places. Indoors, flies tend to rest on over-head structures, particularly on cords and the edges of objects. Where temperatures remain high during the night, house flies frequently congregate outdoors on fences, weeds, and in low branches of trees. Although house flies usually stay within a short distance of the breeding sites, they may become dispersed for distances of several miles. In tropical and subtropical areas, houseflies continue breeding at varying rates throughout the winter. In temperate areas, depending on the weather, these flies survive the winter by pupal hibernation and semi-continuous breeding in protected situations.

(2) Medical Importance. The house fly is found virtually worldwide and is one of the most widely distributed insect pests of importance to mankind. The house fly can harbor over 200 different pathogens, such as food poisoning and dysentery, through mechanical transmission which involves landing on contaminated matter and transferring it as the fly moves around.

b. Blow Fly (*Calliphora vomitoria*)

(1) Biology. Blowflies, also known as bluebottle and greenbottle flies, are identifiable by their large metallic shining blue, green, or black abdomens. They usually deposit their eggs upon carrion; however, they will lay eggs upon a wide range of fresh decaying refuse if carrion is not

available. Eggs may occasionally be deposited in or near body openings of living animals, but clean healthy animals are rarely attacked. Upon hatching, the larvae feed for a short time on or near necrotic tissue on the surface. When fully developed the larvae leave the breeding medium and burrow into loose soil or sand to pupate. The life cycle varies from about 9 to 25 days. Blow flies are keenly perceptive to odors given off by carrion and will fly long distances in response to this stimulus. Although blow flies may serve as mechanical vectors of disease organisms in the same way as houseflies, they do not present the same public health problem since they rarely enter dwellings. The larvae of these flies sometimes referred to as surgical maggots, have been implicated in myiasis.

(2) Medical Importance. The habits of blow flies favor the spread of bacteria and other disease-causing organisms. Blow flies often feed and lay eggs on garbage, manure and carrion before contaminating human foods and food preparation surfaces by landing on them. By doing so, they constitute a great source of diseases transmission to both humans and animals. They can cause traumatic myiasis in humans and animals, and play a minor role in sheep myiasis.

c. Flesh Fly (*Sarcophagidae spp*)

(1) Biology. Flesh flies are medium gray in appearance and are often relatively large in size. They are distinguished from other domestic flies by the presence of three longitudinal black stripes on the thorax and a checkered effect on the usually red-tipped abdomen. These flies are commonly referred to as flesh flies since the larvae of some of them infect living flesh. Many species breed prolifically in animal feces, especially that of dog. They differ from other domestic flies in that the females deposit larvae rather than eggs. Flesh flies are often abundant, but do not ordinarily enter habitations. They do not appear to be of importance to man from the standpoint of mechanical disease transmission, nor are they considered an important pest. However, they are important as an indication of unsanitary conditions and have been associated with cutaneous, genitourinary, intestinal, and nasopharyngeal-opthalmomyiasis.

(2) Medical Importance. The flesh fly carries bacteria, fungi, and pathogenic viruses from fly food sources such as corpses and excreta. These flies are a source of hygienic problems and are a food contamination risk in homes.

d. Bot and Warble Flies (Family: Oestridae)

(1) Biology. These flies cause obligate myiasis. Normally the larvae of bot flies (*Gasterophilus spp*) inhabit the gastrointestinal canal of animals of the family Equidae. Larval development requires 10 to 11 months. In the rare cases of human infection, first-stage larvae are found under the skin, giving rise to a creeping cutaneous myiasis. Treatment is by surgical extraction.

(2) Medical Importance. Among the warble flies, the larvae of *Dermatobia hominis*, whose eggs are carried by female mosquitoes, can be found under human skin in Central and tropical South America. The life cycle requires 3 to 4 months. Larvae of *Oestrus* species are found in the nasal cavities and cranial sinuses of sheep, goats, and related wild animals. In areas where numerous infested animals occur, humans may also become infested. In these cases, the

larvae may be found in the buccal mucosa and conjunctive, but more frequently in the nasal cavities. Severe frontal headaches result. The larvae of *Hypoderma* species can be found under the skin of cattle, goats, deer, and large game animals. They can give rise to creeping eruption in man. Numerous human infections occur, and incidence is proportionally higher in children than adults. With man being an unnatural host, the larvae may migrate throughout the body (e.g., the eyes dermal and subdermal tissue, the jaw, and the spinal canal). Associated pain is severe, and while death may result, surgical removal is possible. *Cuterbra* species larvae commonly cause myiasis in rodents of many genera and rabbits. In these animals, severe infestations may lead to encapsulating dermal tumors. Occasionally dogs, cats, and humans may become infected. Although rare, in human cases, the larva forms a boil-like lesion in the dermal and subdermal tissue, but the larvae are easily removed.

e. Stable Fly (*Stomoxys calcitrans*)

(1) Biology. The stable or dog fly is bloodsucking and closely resembles the house fly in appearance. It is distinguished from other domestic flies by its piercing proboscis that protrudes bayonet like in front of the head. It normally breeds in wet straw, mixed straw, and manure or piled fermenting vegetation, such as grass, seaweed, and similar materials. Development requires 21 to 25 days. The stable fly is not attracted to and does not breed in human food, feces, garbage, and other filth that are attractive to the house fly. Consequently, it is not considered to be an important mechanical transmitter of human disease organisms. However, its painful biting habits make it a serious pest for morale.

(2) Medical Importance. There is evidence implicating this fly with transmission of anthrax and tularemia. Rarely, it is responsible for accidental traumatic and enteric human myiasis.

3. Filth Fly Surveillance and Control

a. Surveillance. There are many techniques for sampling adult filth flies. For our purposes, the most appropriate are based on counting the number of flies on resting sites or those caught by sticky traps. Sampling should be conducted at a standardized time and at the same locations. The number of flies caught strongly depends on the location of the trap. Locations must be accurately identified so the trap will be placed in the same location for each subsequent survey. Weekly fly surveys should be conducted throughout the fly breeding season.

(1) Fly Bait Technique. Use this technique to determine fly densities indoors. A 3x5 notecard from equipment sets that has been painted with a fly attractant should be placed near a location frequented by flies. The number of flies attracted to the card over a specified time (e.g., 5 minutes) is recorded.

(2) Sticky Tapes. Sticky tapes or strips are used for assessing fly densities, particularly indoors. They may be exposed to flies from 2 hours to 2 days (one day is recommended). In order for data to be meaningful, the length of time and time of day must be uniform from observation to observation. Sticky tapes should be located near doorways or trash receptacles. They should not be placed over food preparation or serving areas.

(3) Visual Counts. The most common method and based on complaints during operations is visual counts. Visual counts can be made of flies landing on a given surface, such as a table top, tent pole, appliance, or even a person in the area. Counts on the same selected surfaces should be made at the same time of day each time a count is made.

(4) Recording surveillance data. A permanent record should be kept of all filth fly surveillance data. Maintain files of such data on a form that provides a record of the number of filth flies counted or trapped, the species observed, and sanitation and exclusion conditions in each facility surveyed.

b. Control. Integration of control methods is essential in filth fly suppression programs. In many instances, sanitation is the key to long-term control. Pesticide application alone is not sustainable, being limited by both time and logistics. However, pesticides constitute the most effective immediate solution for reducing filth fly populations and must be considered when a disease threat exists. Moreover, as discussed earlier, fly problems may originate in areas away from a camp and outside the control of military personnel. This will limit options on control techniques. Pesticide application must always be done according to label guidelines. Pesticide labels are legal documents. Failure to follow label instructions is a violation of Federal law (40 CFR Part 156). All pesticides noted in this manual are authorized for use by DoD-certified pesticide applicators. Several methods of pesticide application can be used in filth fly control. Often one or two methods, such as baits and space sprays, will adequately augment sanitation and exclusion. The choice of application method is dependent upon several factors. In most cases, pesticides and pesticide baits should only be used outdoors. Traps can be used indoors and outdoors. In deployed situations, the type and amount of application equipment are often deciding factors. Good planning is necessary to ensure pesticide formulations match application equipment, and that the planned method of application is adequate to accomplish the task.

(1) Insecticide Baits - Granular Baits. If used correctly, these can effectively reduce adult fly populations. Application: For outdoor use only. Bait should be applied following label specifications. Baits can be scattered over specified fly feeding areas daily or as needed or placed in bait stations. Some formulations can be mixed with warm water to form a paint-on application. These baits are effective in and around dumpsters and garbage cans. Distribute bait directly from the container; specialized equipment is not required. Avoid contact with skin.

(2) Space Sprays and Volatile Insecticides

(a) Outdoor (ULV) and thermal fogging application are the most rapid method of outdoor adult insect control. In situations where fly populations must be brought under control immediately, e.g., to reduce the incidence of diarrheal diseases in operations, ULV and fogging pesticide application is the only assured means of immediate control. Space sprays are effective at killing flying insects over large areas, but results are often short-lived, as insects move in from unsprayed areas. Long-term control strategies should be implemented as soon as possible to reduce reliance on space sprays, which are labor intensive.

(b) Aerosol sprays labeled for fly control can be almost 100 percent effective indoors when used to augment effective exclusion measures. In the absence of exclusion, indoor treatments may be of little value.

(c) Dichlorvos pest strips should be used in garbage cans and in unoccupied areas such as storage containers. Pest strips may be ineffective inside screened structures, as opposed to buildings with solid windows and doors, because air exchange will prevent adequate buildup of pesticide in the air.

(3) Residual Insecticides. Residual sprays can be used to control adult or larval flies. In both cases, efficacy is often poor, but this approach can be useful in certain situations. Residual pesticides are usually ineffective against larvae unless the larval medium is shallow and the pesticide can penetrate and contact the larvae. Applying residuals to inside surfaces of garbage cans, and other areas where maggots are seen should be included in fly control programs. Residuals can be applied in strategic resting areas to control adult flies indoors. Flies are attracted to and will rest on vertically oriented strings, electrical cords or strips. These can be treated if suitable materials are available. Surfaces around garbage handling areas are attractive to adult flies and applying residuals in these areas can be useful. Application: Residual sprays are applied with hand can and backpack sprayers. Hand cans are well suited for small jobs where all areas to be treated are easily accessible. Backpack sprayers are necessary where pesticides must be dispersed over large areas.

(4) Traps

(a) Light traps fitted with replaceable sticky cards are available to capture flies and augment sanitation inside buildings. These traps effectively remove the small numbers of flies that enter well-screened buildings, and should be used on deployments of extended duration in permanent and semi-permanent facilities. They work by attracting flies to an ultraviolet light. Whereas 120 volt electricity is supplied in the Americas, countries in other parts of the world usually have 220 volt electricity, for which appropriately wired traps are supplied by some manufacturers. Insect electrocution devices are not authorized for use indoors or outdoors on U.S. military installations, because they are likely to attract far more flies and non-target insects than they kill and because electrocuted flies can explode and contaminate surfaces.

(b) Sticky traps and bag traps baited with lures can be used effectively in operational environments. Place sticky traps inside facilities and at guard posts to both help control flies and provide surveillance data. Bag traps with lure should only be used outdoors and should be placed away from the area flies are not wanted. Bag traps can be used for extended periods of time and generally work better as they become more odoriferous with decaying flies. Adding water and new lure to old bag traps is acceptable as long as the trap is not leaking.

4. Other Medically Important Flies

a. Tsetse Flies (*Glossina spp*)

(1) Biology. Adults are typically 6-15 millimeters in length. Both males and females are bloodsuckers and found exclusively on the African continent south of the Saharan Desert. Tsetse fly species feed on man and animals and are prominent vectors of the disease African Trypanosomiasis (African Sleeping Sickness) caused by the transmission of protozoan

trypanosomes. It is rare to see tsetse fly larvae as larvae are birthed at full development and pupate almost immediately. Tsetse flies are easily distinguishable by their long wings which extend well past the abdomen and are completely folded one over the other above the abdomen while at rest, as well as a long proboscis that extends directly forward at rest. Adults are a brownish color and take on a medium size and stout appearance.

(2) Medical Importance. *Glossina palpalis* and *Glossina fuscipes* are the primary vectors of the trypanosome that causes African Sleeping Sickness.

(3) Control. Because of the diversity of habits among tsetse flies and the practical absence of a free-living larval form, they are difficult to control. Among the many types of control that have been or are being used are: traps, natural enemies (biological control), cover modification, control of host game animals, establishment of fly barriers consisting of clearings or thickets that would inhibit fly movement or reproduction according to the species involved, and quarantine areas. Aerosol space sprays have also been used effectively for adult control but is more difficult to control because of large areas of forest that must be sprayed.

b. Phlebotomine Sand Flies (Family: Psychodidae)

(1) Biology. Sand flies transmit tropical and subtropical diseases. The flies of these genera are small and moth-like, rarely exceeding 5 millimeters (1/5 inch) in length. Their bodies and wings are densely covered with hairs. The wings are either oval or lanceolate shaped and, when at rest, are held upward and outward to form a 60-degree angle with each other and the body. Only the females have piercing mouthparts for blood feeding. They have a wide distribution, occurring in various terrains such as deserts and jungles, but are absent from the colder regions of the Temperate Zones. They invade open dwellings to bite humans during the evening and night, while hiding in dark, protected places during the day. Indoors, they may be found in dark corners and near the ceilings of sleeping quarters. Outdoors, they hide in masonry cracks, stonewalls, excavations, animal burrows, hollow trees, and deep cracks in the soil. The eggs are laid where there is an abundance of organic matter and sufficient moisture for their development. They are weak flyers. Their mode of flight is characteristic in that, for longer distances, they exhibit slow, steady movement. For shorter distances, they move in so-called "hops." Normally, their dispersal is limited to the immediate region of their breeding areas. The diseases these flies transmit to humans are bacterial (Bartonella), viral (sand fly or pappataci fever), and protozoa (*Leishmania spp*, kalaazar, oriental sore, and American mucocutaneous leishmaniasis).

(2) Medical Importance. Species in the genus Lutzomyia are exclusive to the New World, primarily in the Neotropics and South Nearctic, and those that prefer human blood typically feed during the day or at dusk. They can vector leishmaniasis, Carrion's disease (bartonellosis), and vesicular stomitis virus (VSV). Species in the genus Phlebotomus are exclusive to the Old World, primarily throughout much of Europe and North Africa, feed primarily at night, and can vector of bartonellosis and pappataci fever.

(3) Control. Sand flies have a very short flight range so elimination of potential breeding sites near an infested area will give relatively good control within a limited area. Elimination of these sites may include complete drainage and drying to remove moisture necessary for

development. Stone and rocky areas may be covered with dirt; rock walls, and stone masonry may be either destroyed or faced over with mortar to eliminate cracks and crevices. The flight habits of sand flies render the species vulnerable to the application of residual sprays. The adult flies frequently rest on outer walls before entering a building. They enter by a series of short, hopping flights with relatively long pauses. Once inside, they may linger for a time on the walls before seeking a blood meal source. Application of residual sprays with the equipment and dosages recommended for houseflies and mosquitoes is suitable for the control of sand flies. Sleeping quarters and rooms occupied after dark should be treated as well as doors, windows, and screens. An even greater margin of protection is obtained by spraying the outside of doors, windows, and +0.5 meters of the wall surrounding these openings. The application of residual spray solutions to the interior surface of tents and around the openings, including the flaps, bottom edges, and ventilation openings is also recommended. Emulsion formulations should not be used on tents because they will break down the waterproofing and cause tents to leak during subsequent rains. In some situations, extending the spraying program to include outdoor applications of residual insecticides may expand local area control. This will deny the sand flies the customary outdoor shelters or breeding places, and present lethal barriers between the adult flies and the buildings to be protected.

c. Black Flies (Family: Simullidae)

(1) Biology. Black flies, sometimes called turkey gnats or buffalo gnats, are dark, stout-bodied, humpbacked flies with short, broad, fan-shaped wings in which only the anterior veins are well developed. Adults range in size from 5 to 15 millimeters. The antennae are short and stubby. Its life cycle consists of an egg, larval, pupal, and adult stage. The immature stages of blackflies develop in running water. Following incubation, the eggs hatch and the larvae become attached by a caudal sucker to submerged objects. They feed on microorganisms that are strained from the water while breathing through three small gills located dorsally on the last abdominal segment. The larvae pupate within the cocoon that it spins, firmly attached to a submerged object. Depending on the species and environmental factors such as temperature and availability of food, the total period of the aquatic life stages may vary from 2 to 14 weeks. Metamorphosis to the adult takes place within the cocoon. Upon emerging and rising to the surface, the fly takes wing immediately. Little precise information is available on the dispersal range of blackflies, but it is believed to be more than a mile, particularly in open terrain. Like mosquitoes, both sexes of blackflies feed on plant juices, and only females bite. The females also feed on the blood of wild and domestic animals and birds, while several species regularly feed on humans. Due to the large size of the bite wound and the presence of fly secreted anticoagulant, the bites bleed freely and may become secondarily infected. Several species cause serious annoyance to man because of the habit of flying closely about the face and crawling or probing all exposed skin surfaces. The females vector the filarial parasites that cause onchocerciasis in humans and animals, and the avian protozoan blood parasite, Leucocytozoon.

(2) Medical Importance. In addition to their vector capabilities in the transmission of river blindness, their saliva can hinder coagulation and, if enough bites are present, can result in blood-loss anemia. Human hosts may also exhibit severe systemic reactions to bites resulting in “black fly fever” which is characterized by symptoms such as headache, fever, nausea, adentitis, generalized dermatitis, or allergic asthma.

(3) Control. Blackflies are effectively controlled by the application of larvicides to the streams where the immature forms are developing. Where only one brood of blackflies emerges annually, a single treatment of streams should markedly reduce the fly population. If multiple generations are produced, the number of treatment should correspondingly be increased. Stream treatment should only be initiated when necessary to protect public health. Because of the long flight range of blackflies and heavy population pressures adjacent to the control area, aerosols or mist sprayers cannot be depended upon to provide adequate control. Although the biting rate of blackflies is usually much lower than that of mosquitoes, personal protective measures against them are considered to be essential. Generally, the measures described for protection against in-quarters mosquito bites apply equally to blackflies. Characteristically, blackflies crawl beneath clothing whenever the opportunity present. Therefore, tight-fitting cuffs and collars are important in preventing their bites. Protective netting and fabric must be a minimum 20 mesh per inch and 28 mesh for standard wire or fiber.

d. Biting Midges (Family: Ceratopoginidae)

(1) Biology. These bloodsucking flies, often called no-see-ums, punkies, or salt-marsh sand flies, are extremely small [1 to 5 millimeters (1/25 to 1/5 inch) in length] and have long slender antennae and narrow wings that are carried flat over the body. Unlike mosquitoes, they lack mouthparts necessary to bite through clothing. Although information on their breeding habits is not complete, some species are known to breed in freshwater inlets, tidewater pools, water-holding tree holes, wet decaying humus along densely shaded areas of streams, and in marshes and swamps. Adults may be found as far as 5 kilometers (3 miles) from their breeding sites. The female inflicts a painful bite, attacking humans mainly in the evening and early morning hours. While the diseases and parasites vectored by many species are of veterinary importance, they are not known to transmit diseases to humans and are primarily a concern for the painful irritation and reactions that can result from bites.

(2) Medical Importance. Biting midges can transmit diseases of livestock, but they do not transmit any human diseases. Their primary threat to humans is nuisance biting.

(3) Control. For these flies, it must be determined whether the problem is serious enough to warrant control efforts because they are seldom completely successful. The most effective control is obtained by treating immature stages found through careful soil survey work to demonstrate the presence of the larvae. This procedure is tedious and, even in the hands of experts, subject to a considerable number of false negatives. Where the area supporting larval breeding can be determined, control of larvae can be obtained by the direct application of insecticides to the soil. This is an expensive procedure because control must be done on an area basis at periodic intervals to eventually eliminate entry by adults from surrounding uncontrolled areas. Such treatments must be thorough and, consequently, are also injurious to many forms of aquatic life. These treatments may also lead to a rapid buildup of insecticide resistant flies. Aerosol space spray treatments against the adults, which will be described below for blackflies and mosquitoes, is possibly the most effective control measure presently available for bringing relief to small groups of people. The camp and personnel protective measures recommended for mosquitoes are all equally effective against biting midges. Their extremely small size must be kept in mind wherever mesh or fabric screening is to be used. In order to exclude biting midges,

20-mesh screening is required; however, this will seriously interfere with ventilation. Because of this problem, insecticide treatment of screens can provide considerable control and relief against flies landing on or passing through them. A disadvantage in this control method is that the insecticide on the screen is eventually covered with windblown dirt and dust particles.

e. Horse and Deer Flies (Family: Tabanidae)

(1) Biology. Horse and deer flies are robust insects, with powerful wings and large rounded heads. They range in size from about that of a house fly to nearly 25 millimeters (1 inch) in length. They prefer warm, sunny locations, and are especially active on humid days. Eggs are glued in layers or masses to rocks or vegetation overhanging water or damp soil. The egg stage usually lasts less than 2 weeks. Upon hatching, the larvae drop into the water or to the ground. Depending upon the species, the larvae require 1 to several years to complete development. Mature larvae migrate to dryer soil for pupation where after 1 to 2 weeks the adult flies emerge. These flies inflict exceedingly painful bites through skin lacerations and, when numerous, seriously interfere with outdoor operations or recreation. They are also known to vector bacterial (anthrax and tularemia), protozoan (trypanosomes), and helminthic (Loa loa) infections to humans and animals. Only females are capable of biting, but are often aggressive and persistent. Most horse and deer flies are daytime feeders and are most commonly encountered in hot summer and early fall weather. All medically important species of horse and deer flies occur worldwide in temperate, subtropical, and tropical locations, with some exceptions.

(2) Medical Importance. The primary medical issue is injury to personnel or animals from repeated bites. However, some flies in West and Central Africa can transmit the filarial worm Loa loa, including *C. silaceus* and *C. dimidiatus*.

(3) Control. Control of these pests is difficult and frequently ineffective. Space applications of insecticides similar to those recommended for mosquito control may be effective under some conditions, particularly if applications are made when the adult flies are active. In areas of heavy populations of horse and deer flies, the use of adulticides has not proved to be overly satisfactory. The use of larvicides has the same drawbacks as described for the larval control of biting midges. The personal protective measures described for mosquitoes are fairly satisfactory for protection against these flies, except that current standard repellents are not always successful. Horse and deer flies will occasionally enter quarters, but not for biting; consequently, protection while in quarters is not a problem.

f. Eye Gnats (*Liohippelates spp*)

(1) Biology. Members of this fly family are very small flies [1.5 to 2.5 millimeters (1/16 to 1/10 inch) in length] which have been given the name “eye gnats” or “eye flies” because of their predilection for eye secretions. They are also attracted to wounds, pus, and sebaceous secretions. They are extremely annoying to man because of their persistent habit of swarming closely about the face. The life cycles for many eye gnats are not completely known. The eggs are deposited at weekly intervals on or below the surface of loose, well-aerated non-putrid soil,

which may contain fecal material and plant material. The larvae feed on decaying organic material, including feces, and complete development in about 7 to 11 days. Pupation takes place close to the surface in the larval feeding medium and lasts 6 to 7 days.

(2) Medical Importance. Eye gnats can be mechanical vectors of bacteria which can infect the conjunctiva or open cuts or sores around the eye.

(3) Control. The eye gnat species are the most troublesome to man within the United States. Efforts to effectively control these species by the use of aerial and ground delivered sprays and aerosols have generally been unsuccessful. Eliminating moist outdoor sites that are rich in organic matter aid in control. Areas of problem can be near units where condensation is allowed to pool or improperly drain and head and dining facilities with leaking drainage. Any facility that leaks and collects moisture should be repaired.

8-32. Ticks

1. General. Ticks are blood-feeding arachnid ectoparasites split into two primary families: Soft ticks (family Argasidae) and hard ticks (family Ixodidae) (see Figure 02, Appendix B). This division is made on the basis of whether they have a hard shield-shaped plate on their backs, called the scutum; hard ticks do, while soft ticks do not. All ticks hatch as a six-legged larva, which will molt after a blood meal into an eight-legged nymph. After undergoing one or more nymphal stages, each requiring a blood meal, the tick will molt into an adult. Globally, ticks are perhaps the second most efficient arthropod vector of human disease after mosquitoes, but they are the primary arthropod disease vector within the continental United States.

a. General Soft Tick Biology. Soft ticks can be distinguished from hard ticks primarily by two features: the lack of a scutum, and the body completely obscuring the head and mouth parts when viewed from above. They have multiple nymphal stages – up to eight, depending on the species – and different life stages of a single tick may feed on different host species. Many soft ticks are parasites of birds and so are not important as vectors of human disease, but some soft ticks are parasites of rodents and will live with them in their burrows. This gives soft ticks the unusual ability to infest man-made structures, especially remote buildings that are poorly weatherproofed and rarely used, like cabins or military operations on urbanized terrain (MOUT) training sites. Personnel may then be bitten when occupying these structures. Also unlike hard ticks, which will cement themselves to their host and feed for several days, soft ticks feed quickly, with some species able to finish a blood meal and drop off the host in as little as 20 minutes. Personnel trained to check themselves for ticks after an exercise may therefore never realize they have been bitten.

b. Soft Tick Medical Significance. The only disease vectored by soft ticks is tick-borne relapsing fever, a bacterial disease that causes several days of intense bouts of fever, joint pain, and nausea followed by afebrile periods. It is found primarily in the mountainous American West, especially California and Washington, and may be a risk for personnel occupying remote training sites in these areas.

c. General Hard Tick Biology. Hard ticks comprise the majority of tick species and represent the majority of disease threat to military personnel. They have frontally protruding mouthparts and a hard, shield-like scutum directly behind the head. Hard ticks have a single nymphal stage but, like soft ticks, many species of hard ticks will feed on multiple different hosts over the course of their lifetimes. Most hard ticks are found exclusively in woodland environments, but some will readily enter or even infest man-made structures. Although there can be great variability between species, generally, hard ticks lay batches of hundreds or thousands of eggs at a time and, if temperatures allow, can have multiple generations per year. Ticks seeking a host will engage in "questing" behavior: they will climb onto blades of grass, twigs, leaves, or other protruding surfaces and wait with their legs extended for a host to brush past them. Once attached, ticks will feed for several days before dropping off to molt or lay eggs.

(1) Brown Dog Tick. The brown dog tick is found worldwide and is one of the few hard ticks that will infest structures. Its primary host is the domesticated dog, and it can be a scourge in kennel environments, but it will also opportunistically feed on humans. This tick will lay eggs in batches of several hundred to up to 5,000 eggs in cracks, crevices, and carpeted areas in structures. Larval and nymphal ticks will be found primarily in the fur on the back of the neck and head of dogs, while adult ticks will congregate in the ears of the infested animal. Although it is not a major vector of human disease generally, it can be the primary vector of Rocky Mountain spotted fever in the southwestern United States in areas along the U.S.-Mexico border.

(2) American Dog Tick. Distributed east of the Rocky Mountains, the American dog tick is an orange-brown tick notable for having yellow line patterns around the edge of the scutum and yellow stripes on the joints of its legs. It is the primary vector of Rocky Mountain spotted fever in its range. It can also cause tick paralysis, which is characterized by numbness and paralysis starting in the legs and moving up the body and is caused by a reaction to a toxin in its saliva. Recovery quickly follows removal of the offending tick.

(3) Lone Star Tick. Lone star ticks are small brownish-red ticks; adult females are easily identified by the single large white dot on the rear of the scutum. They primarily vector two of the bacteria that cause human ehrlichiosis, as well as tularemia. Although they are not important vectors of Lyme disease, they can cause Southern Tick Associated Rash Illness, which will produce a bullseye rash similar to the ones seen in Lyme disease. They have also been reported to induce an allergy to red meat.

(4) Blacklegged Tick. This tick is found throughout the United States and is the primary vector of Lyme disease. It has a red abdomen and a dark blackish-red scutum and black legs. It feeds on a wide variety of hosts, but nymphs and adult females are the most likely to bite humans. Biting occurs at the highest frequency in the spring, summer, and early fall, but the tick will be active and search out hosts in the winter provided the temperatures are above freezing.

2. Surveillance

a. Personal Surveillance. Personnel should be encouraged to perform personal tick surveillance if operating in an area where ticks are suspected. Ticks prefer to bite in creases and joints – the armpits, the groin, the backs of the knees – and hard ticks will remain for several

days at a time. Quick detection of a biting tick is important for reducing the likelihood of infection by tick-borne disease. If someone finds a tick on themselves, they should be encourage to use proper tick removal technique and to preserve the tick in a plastic bag or vial. Ticks can be submitted to the Military Tick Identification/Infection Confirmation Kit (MilTICK) Program for identification and testing for disease. The program information and shipping information is available at: https://phc.amedd.army.mil/topics/envirohealth/epm/Pages/HumanTickTestKitProgram.aspx.

b. Tick Drags. Dragging for ticks is the most reliable method of environmental tick surveillance. To drag, a cloth made of durable white or light-colored fabric, such as canvas or corduroy, is cut into at least a 3'x3' square (approximately one square meter) and attached to a rod along one side. The surveyor then drags the rod at a moderate walking pace in a large grid pattern through the target area and counts the number of ticks on the cloth at set intervals. Use of baits like carbon dioxide does not consistently increase the effectiveness of tick drags and so is not recommended. The size of the grid and the number of passes should reflect the size of the target area and the nature of the terrain and should provide a representative sample of what personnel will be exposed to during their operation. Ticks tend to be unevenly distributed in the environment, so it is recommended that the surveyor bring a map and record the number of ticks collected at specific points in their survey grid to facilitate identification of problem clusters.

3. Control. Control of ticks can be difficult and generally requires strong personal protection practices, vegetation clearing, and control of alternative hosts (like rodents or deer). Chemical pesticide application has variable efficacy against ticks and is not recommended as the sole control tool.

a. Personal Protection. Permethrin-treated uniforms provide effective protection against ticks, but even without permethrin treatment a properly worn uniform can still provide a physical barrier. Additional protection can be achieved by wearing a personal repellant containing 30 percent DEET, 20 percent IR3535, or 20 percent picaridin, though this is less effective at preventing bites than permethrin or proper uniform wear. "Natural" or "organic" repellants using plant essential oils have not been proven effective and are not recommended. PPE is the first and best line of defense against tick bites and compliance with a PPE regime should be strongly encouraged among all personnel operating in areas where exposure to ticks is expected.

b. Habitat Modification. Cutting back grass and clearing vegetation that may provide shelter or a questing site can be an effective form of area denial. Ticks are generally quick to desiccate in warm weather and will avoid exposed areas when possible. Whenever practical, removing or at least trimming grass and other tall vegetation around high-traffic areas and sleeping quarters can reduce the rate at which ticks approach field camps. Many ticks that opportunistically bite humans will primarily feed on smaller mammals as larvae or nymphs, so control of these animals can help prevent exposure. Rodent control is particularly useful, as rodents serve as the reservoir for many tick-vectored diseases and rodents may bring larval or nymphal ticks directly into structures while seeking food or shelter. Care should be taken when disposing of dead rodents to reduce potential exposure to ticks. Strict enforcement of rules against the keeping of mascot animals and forbidding interaction with local dogs and cats will also reduce exposure to ticks.

c. Chemical Control. Experience has shown that applications of liquid pesticides labeled to control ticks may be impractical because of incomplete penetration of vegetation. However, adult blacklegged ticks generally quest in the shrub and grassy layer after the autumn leaf drop and again in the spring before leaves appear. The lack of protective foliage during these periods makes adults of this species vulnerable to chemical sprays. Effective control of blacklegged ticks in all stages has been achieved in small areas using a backpack sprayer or hand-operated granule spreader, thereby also reducing environmental contamination of nontarget areas. But such applications are very labor intensive and unsuitable for larger areas. As well, small areas may require frequent retreatment because ticks may be quickly reintroduced by animal hosts. Seasonal applications of acaricides target overwintered nymphs as they become active in the spring and early summer, and possibly larvae in late summer or early fall. Generally, the more active ticks are, the better the control achieved with pesticides (tick activity usually stops when temperatures fall below 54ºF or 13ºC), and localized control provides only localized and temporary relief. When minimal resources are available, treating an area 2 weeks before it is to be used achieves maximum control for the effort expended.

8-33. Cockroaches

1. General. Cockroaches are scavengers and decomposers that, in the wild, live in moist woodland or swampy environments and feed on a wide range of foods. Although there are 4,500 species of cockroaches globally, few are common around human structures and fewer still are likely to infest them. Of these, the German cockroach, represents by far the biggest problem ashore and afloat. For the purposes of the following subsection, "cockroach" refers to the German cockroach. Other cockroaches of interest will be addressed separately at the end.

a. General Cockroach Biology. Cockroaches are hemimetabolous, which means they undergo incomplete metamorphosis: the juveniles at all stages look like the adults, cohabitate with them, and eat the same foods. Adult and juvenile cockroaches can be distinguished by the presence of wings which partially or completely cover their abdomens. However, despite having wings, adult German cockroaches (Figure 03, Appendix B) do not readily fly. Adult German cockroaches are small, about 5/8 inches (16 millimeters) long and are a light brown or tan color with two dark brown stripes down the vertical length of the upper thorax; however, juveniles are reddish-brown with tan legs and tan stripes down the sides of the body.

b. German cockroaches have the highest reproductive output of the cockroach species that commonly infest manmade environments; each purse-shaped egg case, or ootheca, can have 30 to 40 eggs, and females will produce an average of four to five of them during their lifetimes. Females will carry the ootheca with them until just before the eggs hatch. Under optimal conditions, the time from hatching to adulthood is about 35 days in males and 45 days in females, but in the field this can vary wildly depending mostly on temperature. Once mature, cockroaches live less than a year.

2. Medical Significance. Cockroaches are not a reservoir of any human diseases, and they do not directly transmit any diseases to humans. Instead, their primary medical threat is as mechanical vectors of pathogens already in the environment. In places with poor sanitation, cockroaches can drag bacteria, fungal spores, or debris from dirty areas to clean ones as they

move. They may also directly contaminate food and drink with their frass, and may cause allergic reactions in some people. Presence of cockroaches onboard ships can significantly demoralize ship personnel that negatively affect operational mission.

3. Surveillance. Cockroaches prefer to harbor in cracks, crevices, and voids that are dark, warm, and moist. Consequently, while it may be easy to find evidence of a cockroach infestation in the areas where they feed, it may be extremely difficult to identify the actual harborages they use. Failure to do so is likely to result in failure to eliminate the infestation, so effort should be made to locate and survey as many potential spots as possible.

a. Inspections. When performing an inspection, the minimum recommended tools are a flashlight and hand mirror. Cockroaches are nocturnal, so inspections made during the day (or when the lights are on) are unlikely to directly observe cockroach activity unless the infestation is extremely heavy.

b. Common Signs of Infestation. There are three indirect signs of cockroach infestation: frass, body parts, and odor. Cockroach feces, called frass, are small, dark, and look similar to spilled coffee grounds. Frass is found in high concentrations close to cockroach harborages or in areas with significant feeding activity. Juvenile cockroaches may leave behind molted exoskeletons, and dead cockroaches that are not cannibalized will leave body parts (often legs or wings). Finally, in very heavy infestations, groups of cockroaches may give off an oily, musty odor, though this is an unreliable indicator can be difficult to detect in shipboard environments.

c. Preferred Harborage Locations. Cockroaches harbor in locations that are warm, dark, moist, and close to areas with ready food. Their preference is for tight gaps where both their dorsal and ventral sides can be in contact with a surface, and as such, they often can be found in mechanical spaces, especially underneath panels or within motor casings. In shipboard galleys, they can be found harboring inside the motor housings for mixers or fryers or the compressors for refrigerators. They may also be found in compactor rooms and other areas where trash is stored before disposal.

d. Flushing Agents. Flushing agents are insecticides that will drive cockroaches out of harborages. They are especially useful to check cracks and crevices that would otherwise be inaccessible to observation, such as the narrow gaps between bulkheads and tables in ship galleys. Flushing agents should not be used if there is risk of moving cockroaches to other areas. Flushing insecticides are very effective for pier side inspections.

e. Passive Surveillance. Glue traps can be used to passively surveil for cockroaches. Traps should be placed against walls or bulkheads in areas where cockroaches may travel and the locations and placement dates of all traps should be tracked by the manager of the pest control program. If the traps are being placed as part of an attempt to locate a cockroach harborage, or if an infestation is suspected, traps should be checked daily and the number of new catches, the proportion of adults to juveniles caught, and their position and facing on the trap should be noted. If traps are placed as part of an ongoing surveillance program and not in response to a specific problem, they should be checked bi-weekly per reference (g) and replaced if they become too dusty or are removed during cleaning.

4. Treatment. Treatment for cockroaches should include a sanitation program at a minimum. Failure to thoroughly and continuously sanitize spaces will dramatically increase the likelihood of control failure. Sanitization removes competitive food sources and improve success of poison baits. Options for chemical control include poison baits, barrier treatments, and IGRs, but not all of these options may be authorized for use afloat depending on your platform. Sticky traps, while effective as a means of surveillance, are not effective as a means of control and should not be used as such. Finally, all areas where chemical controls measures are to be applied should be cleaned beforehand so that applications are made onto a clean surface.

a. Poison Baits. Poison baits come in two primary formulations: pre-packed bait stations and gel applications. Bait stations are the most familiar to most users and are authorized for use on almost all vessels and shore facilities. They contain a pesticide which has an attractant and is lethal when consumed or when cockroaches eat the feces or body of a cockroach that received a lethal dose. Gel baits operate the same way, and may even contain the same active ingredient, but come in a syringe that allows for application within areas where a bait station is not feasible. When deciding between these two formulations, it is important to determine: how likely the application area is to be disturbed, whether by routine traffic or cleaning; how distributed cockroach harborages are likely to be; and the severity of the infestation. Bait stations are less likely to be disturbed or damaged during routine operations but may not be effective for heavier or more widely disbursed infestations.

b. Barrier Treatments and Residuals. Even when a pesticide is authorized by the label for use in food preparation or storage areas, care still needs to be taken to avoid potential contamination of food. It is recommended that all food items be removed from the area before the spray, that the spray take place outside of regular cooking hours, and that surfaces used for food preparation be thoroughly cleaned before cooking takes place again. Removable panels or casings can be safe to spray, but care should be taken not to directly apply liquid pesticide directly to electric equipment like motors or pumps. A dust may be a more effective treatment option for these machines. Consult with your cognizant NAVENPVNTMEDU or NAVENTOCTR for help with selecting the best pesticide to treat your facility. One note of caution for residual applications: if spraying is being used in conjunction with bait stations or gels, the residual should be applied first and allowed to thoroughly dry before the bait is applied. Residuals have a repellant effect on cockroaches, and if a spray is applied over a bait station, it will reduce the likelihood of cockroaches visiting that station or eating the bait. If bait stations are already in use, they should be collected and stored during the residual spray, then redeployed after the spray is finished.

c. IGRs. Cockroaches use hormones to control their molting and maturation processes. IGRs interfere with this to prevent the cockroach from reaching adulthood and sexual maturity. The population then crashes as the number of adults capable of reproducing dwindles. Use of IGRs is attractive for a few reasons. There is no analogous hormone in humans, so IGRs are safe to use in almost all spaces. IGRs are effective even when cockroaches are resistant to other chemical control measures. IGRs stimulate appetite in affected cockroaches so work well in conjunction with baits. However, there are drawbacks to using IGRs. They are non-lethal and IGRs have no effect on reproductively mature adults. Because of these reasons, it is recommended that IGRs only be used in conjunction with other chemical control measures and may be mixed with other insecticides as long as it is in the recommended ratio.

5. Other Species of Cockroaches. Listed in article 8-33, subparagraphs 5a and 5b are two of the most common species of cockroaches likely to be encountered in the field or aboard military installations. Like German cockroaches, these species represent a mechanical disease transmission hazard and can be controlled in the same manner.

a. American Cockroach. Adult American cockroaches are approximately 2 inches (54 mm) long, with reddish-brown wings and a band of light tan coloration on the thorax above the wings. They prefer warm, moist environments between 70ºF and 80ºF (21-27ºC) and eat decaying organic material, fungi, and small insects. Despite its name, the American cockroach has a global distribution and is especially common in buildings in Asia and South America. It can also infest ships, especially via the receipt of supplies that have been stored in infested warehouses. On military installations, it primarily lives in the sewer and steam tunnels, but during warm summer months it will also infest lawns, planter beds, and other vegetation. American cockroaches will readily enter buildings through drains or occasionally through windows or doors that are poorly weatherproofed, but are unlikely to establish an infestation without significant access to food debris or trash.

b. Oriental cockroach. Adults are around 1 inch (25 millimeters) long and a uniform dark reddish-brown or black color. This species of cockroach is more tolerant of cool temperatures than other cockroaches, and is therefore especially likely to infest basements or cellars in the more temperate climates of the northern United States or Europe. However, this cockroach is generally found outdoors and can be kept out of buildings with good weatherproofing and other exclusionary measures. If an indoor infestation of oriental cockroaches is discovered, successful control strategies should include clearing vegetation and plant debris away from the infested building.

8-34. Stored Product Pests (SPP)

1. General Characteristics. Stored products pests infest a wide variety of subsistence supplies including cereals, flour, farina, grits, candy, pet food, and any other non-canned food plus various animal fiber items, e.g., blankets, uniforms, and boots. SPP include the saw-toothed grain beetle, flour beetles, warehouse beetle (Trogoderma), Indian Meal moth, and many others.

2. Medically Important Species

a. Dermestid and Khapra Beetle

(1) Biology. Adults and larvae are generally brown in color and covered with yellowish hairs. In contrast to other dermestid species, it feeds on grains and cereal products, instead of animal products. Adult Khapra beetles may live a few days to several months. However, the larvae are especially resistant to starvation, and may live for several years without food. A small infestation can quickly develop into a large population and, unless completely eradicated from a ship, can continue to survive unnoticed in small numbers for long periods of time. The Khapra beetle has become a quarantinable insect of medical importance worldwide. Because all dermestid larvae have external hairs (see Figure 04 in Appendix B), and because the Khapra beetle is difficult to distinguish from other dermestid species, any dermestid infestation must be

handled aggressively. Every effort must be taken to ensure complete control and thorough destruction of the infested product. The presence of one or more living or dead larvae of Khapra beetle or other dermestid must be justification for condemnation of the lot per reference (j). An adult female can produce approximately 100 eggs during her lifetime. Most dermestid beetles are common pests in warehouses throughout much of the world. The adults and larvae are capable of penetrating both polyethylene and foil packaging.

(2) Medical Importance. Dermestid beetles are medically important because hairs on the outside of the larvae can cause intestinal trauma.

b. Flour Beetle

(1) Biology. The red flour and confused flour beetles are very similar in appearance. Flour beetles appear as shiny, flattened, reddish-brown insects. The head and upper parts of the thorax are densely covered with minute pitting. The wing covers are ridged lengthwise. The terminal three antennal segments of the red flour beetle are distinctly larger than the other antennal segments. In contrast, the antennal segments of the confused flour beetle gradually increase in size throughout their length, like the shape of a baseball bat. Both species are common pests of crackers, cereals, flour, and other grain products. While adults of the red flour beetle can fly, the confused flour beetle does not. Neither are good package penetrators, usually relying on existing openings. The female flour beetle lays an average of 440 eggs in her lifetime. Each egg is covered with a sticky secretion that allows the egg to adhere easily and securely to the seams of sacks and boxes. The adult may live 2-3 years.

(2) Medical Importance. When present in large numbers, both species cause flour to turn gray in color. Adult flour beetles also secrete benzoquinones, which impart a disagreeable taste and odor to infested products. The reported toxic and carcinogenic effects of the benzoquinones and possible levels in stored foods indicate a potential hazard. Because of this, a tolerance level of only 3 or more insects per pound of flour beetle infestations is lower than the limit of 7 or more insects per pound for most other insects per reference (j).

3. Less Medically Important Species

a. Saw-Toothed Grain Beetle. The saw-toothed grain beetle is one of the most common stored product pests. It can infest a wide range of commodities including grain products, dried fruits, candy, sugar, dried meats, and tobacco products. The adult is slender, flat, and brown. It is easily recognized by the six saw-toothed like projections on each side of the thorax. The female can lay as many as 280 eggs during her lifetime. The adult usually lives 6 to 10 months, but some may live for up to 3 years. The merchant grain beetle is nearly identical in appearance, similar in habit, but more abundant in the Pacific region. Both are poor package penetrators, normally utilizing breaks along seams, vent holes, or other openings.

b. Rice Weevil. The rice weevil is considered to be one of the most destructive of the stored products pests, feeding on a variety of raw grains and grain products. Adults are reddish-brown and have a long “beak” or “snout” that extends out from the head and may be as long as ¼ the length of the body. The adult can be easily recognized by the presence of two yellowish or reddish spots on the top of each front wing.

c. Indian Meal Moth. The Indian meal moth is distributed world-wide and is the number one pest of dried fruits in storage. It also infests other commodities, including grain products, nuts, powdered milk, candy, and pet food. It can be a problem, especially with packaged food items in vending machines and snack areas aboard ships. When infesting grain products, it prefers coarse flours and is commonly found in items such as cornmeal. The fully-grown larvae are large compared to other common SPPs (about ½ inch long). The most commonly seen "white worms" found in packaged dried fruits are nearly always the larvae of this moth. They also produce a noticeable silk webbing. The adults of this moth have a grayish band across the upper 1/3 of their reddish-bronze wings. The female moth lays from 100 to 300 eggs during her lifetime.

d. Cigarette Beetle. The cigarette beetle infests a wide variety of foods including grains, spices, herbs, dried meats, drugs, and pet food. The adults are very active and readily fly, increasing the risk to adjacent food stores. They are capable of penetrating both polyethylene and paper packaging. The adult is light-brown in color and appears rounded. The head is bent downward, giving the adult a hump-backed appearance. The last segments of the antennae are saw-like or triangular, and the hardened front wings are smooth in appearance.

e. Drugstore Beetle. The drugstore beetle, similar to its close relative the cigarette beetle, is very active and will eat a wide variety of foods. In addition to food products, they can consume paper and wood and can be serious pests in books. They have little difficulty penetrating metal foil packaging. The adult is reddish-brown in color. In contrast to the cigarette beetle, the last three segments of the antennae are elongated and sausage-like in shape. The front wings have parallel lines along their length. Its life history and habits resemble the cigarette beetle.

f. Booklice. Booklice are minute insects about the size of a pinhead and are sometimes found covering stored food products (flour, cereals). These almost transparent insects are about 1 mm long. They feed on cereal products, vegetable and animal debris, paste, glue, and other organic substances. However, their preferred foods are molds and fungi. Each female lays up to 100 eggs, growing from egg to adult in about 3 weeks.

4. Surveillance

a. Finding Infestations in Storerooms. This is a tedious operation unless the insect populations are large enough to render the product unfit for human consumption (1-7 insects per pound depending upon the species) and spreading to other food products. Food items at highest risk include farina, grits, pet food, and any food that has been packed for at least 6 months.

b. Products Prone to Infestation. It is essential that products at risk for infestation be checked upon receipt. Those near or past the inspection test date (shelf life) must be checked monthly to find the insects before they destroy the product and contaminate other products on the ship or in the storage facility.

c. Pheromone and Food Attractant Traps. Pheromones are chemicals secreted by an organism that cause a specific reaction by the other members of the same species. Because the pheromones are so specific, an entomologist needs to be consulted to determine if these traps are appropriate for a particular area and which traps should be used. Some of the traps for crawling insects also have a food attractant in them.

d. Inspection Responsibilities. Army veterinary food inspectors ashore conduct facility, vehicle, and product inspections. Aboard ship, the Medical Department representative is authorized and should conduct product (Class 9) inspections as per reference (k), while the ship is not in port to extend shelf life as appropriate. Aboard ship, the Medical Department representative should conduct a stored product pest survey every month and appropriately log the results.

e. Reporting Responsibilities. All infestations must be reported. Check reference (k) to determine if medical has the responsibility for your command and the appropriate reporting channel.

5. Control

a. Sanitation. All broken containers, torn sacks, and spilled foodstuffs should be removed promptly; decks should be swept and vacuumed before receipt of new stores.

(1) Infested items must be isolated or promptly disposed of to prevent contamination of other materials.

(2) Spilled food is an open invitation to insects and rodents, it is the responsibility of inspectors to document every sanitation problem and for management to correct the deficiency.

b. Insect Control. Contact the area entomologist to determine if space treatment or residual pesticide application is appropriate for the particular storage area. Once a product is infested but still consumable, freezing it for 2 weeks will kill all life stages of the insects except the eggs. Allowable levels of infestations are outlined in reference (j).

8-35. Vertebrate Pests

1. Rodents. Rodents represent a broad range of threats: through direct transmission of numerous viral or bacterial diseases; by serving as a delivery vehicle for ectoparasites like fleas; and through the structural damage and loss of food stores their activities cause. The two categories of rodents that represent the largest threat are rats and mice; although other burrowing rodents, such as voles, may also cause minor damage.

a. Rats

(1) General Rat Characteristics. Rats and mice both have poor eyesight but excellent hearing and smell. Neither rats nor mice will hold their urine as they move, so urine trails – visualized under UV light – can be used to determine location and sometimes the direction of the path traveled by the rodent. Rodent teeth grow continuously during their lifetimes and must be worn down through constant gnawing. Rodents will chew on any exposed surfaces and can wear completely through hard plastics or metals like iron or copper. However, rats have a special affinity for wires and pipes and will work to chew through any such objects obstructing the paths they usually travel, creating a major risk for electrical short or fire.

(a) Female rats reach sexual maturity within 2-3 months of birth and have a gestation period of 20 to 25 days, depending on the species. Norway rats generally have larger litters less frequently, but a single female rat can give birth to thirty to forty pups during her lifetime, if resources are abundant enough. Baby rats will begin leaving the nest and foraging at around a month old and will be completely independent of their mothers by 3 months of age. Rat life expectancy in the wild is about 6 months, but wild rats can live up to a year in some cases.

(b) Rats are nocturnal, usually beginning activity within an hour or two of sunset and ceasing it shortly before dawn. However, rats in urban environments may adjust their peak foraging periods based on human activity, and individual rat colonies may be most active at different times of the night. Rarely, rats may even be active during the daytime, especially if it gives them the best chance to get food; however, if large numbers of rats are seen during the day and there is no obvious food incentive, it is a sign of an extremely heavy infestation. Generally, you should expect that rats will be most active when they have the best access to food and are least likely to run into a person or predator.

(c) Rats and mice both prefer to eat in a secluded location away from the food source whenever possible. Rats will only feed in the open when there is no alternative. When a rat locates a food source, pieces of food will be carried or dragged to its eating spot and finished there before the rat returns for additional food.

(d) Although behavioral preferences for each species are listed in article 8-35, subparagraphs 1a(1)(a) and 1a(1)(b), it is important to note that all rats are capable of climbing and jumping, all rats may access buildings at ground level or through the roof, and all rats may nest in basements or in attics. Individual rats within a species can show a wide degree of variation in size, appearance, and behavior that can make their control uniquely difficult. It is best to remember that rats are a frustratingly clever and adaptable foe.

1. Norway Rat. Also called the brown rat, sewer rat, wharf rat, and gray rat. Description. Adult Norway rats are large, approximately 16 inches from nose to tail tip and with an average weight of about 12 ounces. It is a stocky, bulky rat with small ears and a tail shorter than its body length. The coat is typically grayish-brown, but may vary from pure gray to reddish-brown. Norway rats are a burrowing species, and so will dig tunnels in field environments or opportunistically use underground passages like sewers or basements in urban environments. Excavated burrows are typically shallow – within 18 inches of the surface – and have a primary entrance with multiple secondary access points to the main nest chamber. Norway rats have been noted to be robust swimmers and may even enter the water to catch small fish.

2. Roof Rat. Also called the black rat, ship rat, and house rat. Description. Adult roof rats are about the same total length as Norway rats, but are generally lighter (between 8 to 12 ounces). The characteristic feature of this species is that its tail is longer than its body. In comparison to the Norway rat, it is also sleeker-looking, has larger ears, and tends to have noticeable guard hairs on its back. Coat color is dark, usually black, with a light grey or cream-colored belly. In their native habitat, roof rats nest in trees; in urban environments, they prefer to

nest in attics and crawlspaces within buildings. They are also generally better at climbing and jumping than Norway rats and can enter buildings to forage by scaling adjacent vegetation and hopping down onto the roofs.

(2) Medical Importance. Rats are medically significant in several ways. First, they can directly transmit several important diseases. Second, they serve as reservoirs for diseases that can be transmitted by their ectoparasites, as with fleas and plague. Third, their urine and feces can contaminate food, and their destruction of packaging can allow insects or other pests to infest food stores.

(a) Diseases. Rodents can directly vector several diseases, such as hantavirus, rickettsial diseases like murine typhus, and leptospirosis. In these cases, the disease is contracted through contact with rodent bodily fluids or contact with surfaces contaminated with rodent bodily fluids. Hantavirus is particularly an issue in places like MOUT training sites, which are used infrequently, situated remotely, and partially or completely open to the environment year-round. In these areas, personnel can become infected by inhaling dust contaminated with rodent urine or feces. Leptospirosis can be transmitted either directly from rodent bites or indirectly through skin contact with standing water or moist soil that has been contaminated with infected rodent urine. Care should be taken when entering recently flooded areas that are known to harbor rodents.

(b) Secondary Parasites. Rodents can bring with them a number of ectoparasites, such as fleas and larval ticks, which can subsequently transmit diseases to humans. The most consequential of these diseases is bubonic plague. Fleas will leave a rodent to lay eggs or in search of a new host if the current one dies. Personnel handling live or recently deceased rodents should be careful to not directly touch the animal and to bag the carcass as quickly as possible to prevent parasites from escaping.

(c) Contamination. Food stores contaminated by rodents should be condemned. Packaging should be thoroughly inspected to ensure it has not been breached. If the outer layer of packaging has been breached, but the inner layer appears to be intact, the food may be used provided it is not contaminated. However, it can be difficult to make this determination with certainty when dealing with things like fruit and vegetables which are not completely enclosed in secondary packaging. It is better here to err on the side of caution and assume the food stores are contaminated.

(d) Cleaning. If personnel will be occupying and training in buildings that are infrequently used, it is recommended to clean the parts of the site that will have the highest utilization a day or two prior in order to reduce the risk of contracting rodent-borne diseases through contact with contaminated surfaces or inhalation of contaminated dust. Cleaning should consist of removing debris and washing down floors and walls with a dilute 10 percent bleach solution. Do not attempt to vacuum or sweep dust, even if the vacuum is equipped with a HEPA filter. Properly fitted N95 respirators, nitrile gloves, and eye protection should be worn by all personnel on-site during cleaning.

b. Mice. General Mouse Characteristics. The most common species of mouse found indoors in the mainland United States is the house mouse, but many species of mice will opportunistically enter or infest buildings. Mice are smaller than adult rats, at about 5 to 8 inches from nose to tail tip, and weighing 0.5 to 1 ounces. They can be distinguished from young rats by smaller hind feet and a head that is proportional to their bodies (the heads of young rats are large relative to their bodies). The house mouse has a reddish-brown to gray coat with a pale white underbelly.

(1) Mice establish small territories and will move erratically within them in search of food. Mice feed by nibbling: they will take small amounts of food from as many different food sources within their territory as they can find, and will try to avoid sitting in one place and feeding from one source for more than a few minutes at a time. They are omnivorous, but in environments where food is abundant (such as storehouses or commissaries), they may prefer to feed on a narrow selection of foods. Extensive research has found that mice tend to stay closer to their nests than rats: one large study found that 90 percent of mice did not go more than 30 feet from their burrows, with the average travel distance at 12 feet. The less food there is in an area, the farther a mouse will travel to find some.

(2) In the wild, mice will live 5 to 6 months, but can live up to 2 years in ideal conditions. House mice prefer to nest in buildings, but may also create burrows in planter beds or lawns adjacent to buildings. Mice have a gestation period of 18 to 21 days and produce litters with an average of five to six pups; these will begin leaving the nest and foraging by about 21 days old. Under ideal conditions, they will reproduce year-round.

c. Surveillance. Rodents leave tell-tale signs of their presence and activities. Before any control program is implemented, a thorough survey of the area should be done to determine the size of the infestation and the species involved. Snaps traps alone do not make a sufficient surveillance program. The best tools for rodent surveillance are a flashlight, a portable ultraviolet light, and a hand mirror.

(1) Droppings. Rodent feces can be used to determine the species and the magnitude of the infestation. Norway rat feces tend to be deposited in groups and are about 3/4 inch on average, boxy, and have rounded or blunt ends, while roof rat feces are usually more scattered, about 1/2 inch long, thinner, slightly curved, and have tampered or pointed ends. Mouse feces resemble roof rat feces in shape, but are deposited in larger clusters and are only about 1/8 to 1/4 inches long. Depending on their diets, a mouse can deposit up to 100 feces per day, while rats produce 40 to 50 per day. Rodent feces tend to be deposited most heavily in either areas where food is found or in the areas rodents take the food to eat. Fresh feces are putty-like and have a shiny appearance, but within a few hours (depending on ambient humidity) they will become dull and will easily disintegrate when pressed. The presence of fresh feces indicates an active infestation, but dry feces only indicate that a rodent was present at some point.

(2) Runways and Tracks. Rodent hair is naturally oily. As rodents travel along their usual paths, this oil will rub off onto surfaces they contact and will eventually form a dark, greasy stain called a runway. This grease is persistent if not cleaned off, so while the presence of

a runway does not necessarily indicate an active infestation, it can help you map the paths rodents take between their burrows, food sources, and eating areas. Rodent tracks tend to be difficult to distinguish unless a significant amount of dust has built up in an area. For surveillance indoors, sprinkling a thin layer of talcum powder along a suspected rodent runway will help you determine whether the runway is currently used and what direction the rodent is travelling along it. Outdoors, dust often blows away quickly, but frequently used rodent paths will be worn free of low-lying vegetation like grasses.

(3) Gnaw Marks. Rodents will gnaw on things that line their usual routes and will chew holes through barriers or obstacles. Tracing damage from rodent gnawing can thus help you map the paths rodents travel in the event runways are not easily visible. The age of a gnaw mark can be determined by the level of oxidation of the exposed surface; freshly gnawed wood, for example, should be lighter than the surrounding wood and may have a splintered appearance. Although rodents can fit through any hole large enough to accommodate their skulls, they will try to enlarge holes or gaps they use over time. Older gnaw holes should have a smoother surface than fresh ones, and may have runway-like oil deposits along the inner surface of the hole.

(4) Urine. Rodents use urine to communicate a wide array of information to each other, including territorial markings. Furthermore, rodents do not hold their urine and will release it as they move. Rodent urine fluoresces under ultraviolet light and, in areas where it may be difficult to see tracks or runways, this can be used to determine where rodents are traveling. Fresh urine glows yellow on burlap bags and a pale blue-white on paper but will change to a greenish color after a few days. However, caution should be taken when surveying for rodent urine, as many other things will glow like this under ultraviolet light, including bleach, certain glues, some kinds of dyes and many paints. If you find a suspected urine patch without other rodent signs, it may be a false positive.

d. Control

(1) Rodent Proofing. The most effective means of control for rodents is exclusion and sanitation, so much so that a trapping program carried out without it is likely to fail.

(a) For shore facilities, exterior faces of a building should be inspected for potential entry points. Ventilation openings should be blocked with intact grates, shades, or at least 18-gauge wire meshes. Places where pipes enter buildings above ground level should not have gaps in the wall around the pipe. Weatherproofing underneath doors should be checked on a regular basis to ensure it contacts the ground and that it is free of gaps or cracks. If the building has roof access, vegetation or debris should be regularly cleared from the top of the building and ventilation shafts should be inspected to ensure they are intact and that there are no gaps that might permit rodents.

(b) For ships, lines to the ship should be kept out of the water and physically separated from each other whenever practical. Additionally, any lines connecting ship to shore should have rat guards installed. The best rat guard is a gently sloped cone with a radius of 36 inches with the open end of the cone facing the shore. Rat guards should be placed at least 6 feet

from the pier and at least 2 feet away from the ship. If two or more lines are close together, their rat guards should be placed such that their outer edges are flush with each other. Flood lights should be used to fully illuminate all other connections between the ship and the shore, other ships, or barges from sundown to sunrise. Trash on the pier should be kept as far away from mooring points as possible and dumpsters should be locked tightly closed overnight if possible.

(c) In all cases, ensure personnel do not keep food in their desks or berthing spaces, that trash is removed from all spaces at the end of the day, and that food preparation and storage areas are routinely and thoroughly cleaned.

(2) Traps. There are two main types of traps for rodents: mechanical and sticky or glue traps. The latter are not preferred because they do not immediately kill the rodent, the animal can often successfully escape or avoid the trap, and the traps become less effective over time as dust and debris sticks to the glue. It is better to use mechanical traps. Additionally, care should be taken when placing and maintaining traps to ensure they do not become contaminated with insecticides, as the smell of insecticides will increase rodent wariness of the trap. If spraying for insects is necessary, rodent traps should be removed first and not returned to their previous locations until after all pesticide application has been completed.

(a) Snap Traps. The use of expanded triggers is strongly recommended to increase the likelihood of the animal touching the trigger while eating. Snap traps are an ideal control mechanism for control of light to moderate infestations of rodents and as part of rodent surveillance programs, but will have difficulty controlling heavy infestations. During trapping periods, all traps should be checked at least once per day, any rodents caught should be promptly removed and disposed of, and baits replenished. Ensure the correct size of trap is being used to address the problem: rat-sized traps are not effective for mice and vice versa.

(b) Trap Placement. When trapping for rats, traps should be placed across runways and in areas where rat activity appears highest, and oriented such that the trigger faces into the runway to encourage the rodent to interact with it. Areas of peak rat activity are generally secluded, have feces and food debris left over from feeding, and may also have tufts of rodent hair shed during grooming. Traps placed directly into these areas may be avoided by the rat, but traps placed at the entrances to them are usually effective. For mice, it is more effective to saturate an area with traps to exploit the animal's erratic food searching behavior. Mice prefer to skirt walls and pass beneath areas with overhangs to avoid predators, so placing traps in these locations with the trigger toward the wall is best.

(c) Trap Baiting. Baiting incentivizes a rodent to interact with your trap and greatly increases the likelihood of a catch. Bait should be applied directly to the trigger of the trap as close to the spring mechanism as possible. The ideal bait is something like peanut butter that will stick to the trigger and which can't be easily taken away during feeding. Uneaten bait should be removed and replaced on the trap regularly to prevent fouling and mold growth, which will repel rodents. Prior to setting the trap, it is often necessary to pre-bait. This involves placing bait onto the trigger without setting the trap in order to familiarize the rodent with the trap and reduce its wariness. When rodents have eaten the bait for several days, they have

accepted the trap and the mechanism can be set. Finally, a note of caution: if alternate food resources are abundant near the trap, rodents will preferentially eat the other foods and ignore the bait. In these cases, adjusting the bait to match the food the rodents seem to favor gives you the best chance of making catches.

(d) Trap Maintenance. The most important aspect of trap maintenance is ensuring the smooth and quick function of the kill mechanism. Regularly check to ensure springs are free of rust. If maintenance is required, remove rust mechanically, not chemically, and grease the spring with a mild cooking grease like Crisco. Industrial lubricants should be avoided since their strong smell will reduce the likelihood of trap acceptance even when baits are used. Generally, snap traps do not need to be cleaned between every kill. There is evidence that the smell of other rodents having visited a trap, left by the oils on their fur, increases the likelihood and speed of acceptance of the trap by subsequent rodents. Rinse any viscera and blood from the trap and reset it after each kill. If more thorough cleaning is necessary, use a mild, scent-free kitchen soap and ensure the trap is thoroughly rinsed and dried before reuse.

(3) Poison Baits. Poison baits are the best option where continuous control programs are necessary, rodent proofing is difficult, and personnel will not have the ability to routinely check and maintain mechanical traps. However, baits come with a few notable drawbacks: they can take several days to actually kill a rodent; they are legally required to be placed in tamper-proof bait stations (40 CFR Part 156); and when the rodent finally does die, it may do so in wall or ceiling voids, leading to health and comfort issues as the body decays. For these reasons, the use of poison bait is not authorized on naval vessels unless express permission is given by the local NAVENPVNTMEDU or NAVENTOCTR and the program is supervised by a Navy entomologist. Poison baits used on shore installations should only be used outdoors.

2. Other Mammals. In addition to rodents, a variety of animals may construct burrows in field environments, such as voles, squirrels, and beavers. The biggest threat from these animals is usually plague or rabies, but they can also cause damage to structures or vegetation.

a. Dogs and Cats. Dogs and cats can represent a serious threat to the health of forward operating American forces and mascots and pets are not allowed or authorized under any circumstances. Significantly, they are the most likely source of exposure to rabies for deployed personnel in many parts of the world. Keeping mascots or pets increases exposure to other vectors on the animals such as ticks and fleas. Their activities may also represent security threats and could contaminate food stores.

(1) Dogs. The easiest way to control dogs is to limit their access to food, both by securing food waste and prohibiting personnel from feeding them. The best tool in your arsenal is engaged small unit leadership: strenuously emphasize at all levels of command that, pets and mascots represent a significant health risk and threaten mission accomplishment.

(a) However, in the event feral dogs are still approaching your installation or camp, or when they appear rabid, it is necessary to catch and remove them. If you suspect any animal is rabid, it is absolutely imperative you do not come into direct contact with its bodily fluids and you do not get bitten. Avoid cornering the animal, as doing so will cause it to lash out.

(b) Feral dogs and cat capture should be coordinated with Army vets for humane euthanasia.

(2) Cats. Although the popular perception is that cats are good at controlling rodent infestations, research has shown that domesticated cats do not significantly reduce rodent populations in urban environments, and well-fed cats are unlikely to catch rodents. Thus, there is little practical value to allowing cats to wander on your installation.

b. Bats

(1) General Bat Characteristics. Bats can range in size from very small bats, to the giant flying foxes of equatorial Africa, Southeast Asia, and northern Australia, which can weigh several pounds and have a wingspan of almost 5 feet. Most bats eat either insects or fruit.

(2) Medical Importance. Bats can transmit a wide variety of diseases, but the most significant is rabies. If a bat is found lying on the ground, it should be assumed to be rabid. Additionally, inhaling the dust from bat feces, or guano, can cause histoplasmosis in humans.

(3) Control. Bat control is limited to exclusion and physical removal as no lethal pesticides are registered for bat control. Seal off exterior holes or cracks larger than 3/8 inch that can lead into overhead voids. Ventilation holes should have grates or wire mesh installed. If bats are roosting in open bay spaces like warehouses, install netting or wire mesh to block access to the rafters and keep the area as well-lit.

3. Snakes. Highly venomous snakes including vipers, mambas, and cobras, can be found in almost every habitat in the operational areas of responsibility (AOR). Snakebite envenomation can present a potentially acute lethal hazard; therefore, personnel must understand what actions to take in such an event. Deployed military forces are generally at low risk from venomous snakebites. For more than 10 years, there have been no snakebites requiring antivenin. For these reasons, snake avoidance is the primary strategy for force health protection against snakebites.

a. Control. Generally, snakes only become a major issue if you already have a major issue with their prey, so the best control is achieved by a reduction in the populations of birds and rodents. Habitat modification by clearing low-lying vegetation, removing piles of rocks, wood, or plant debris, and trimming shrubs will discourage snakes from coming too close to areas frequented by personnel. Filling the entrances to rodent burrows will deprive snakes of nesting sites. However, this may not be a feasible strategy in field environments, in remote and infrequently used training areas like MOUT sites, or in areas where the prey species are protected by law. In these cases, snakes must be physically removed. Snake tongs should be used to handle snakes, and protective garments should be worn on lower extremities to prevent bites. Once caught, snakes should be placed in a sealable hard container for relocation. Never attempt to capture a snake by hand.

b. Field Treatment for Envenomization

(1) It is important to reassure the patient and provide the information in article 8-35, subparagraphs 3b(1) through 3b(7) in order to alleviate irrational fear and to help calm the individual.

(2) Do not tamper with the bite wound. Gently wipe the bite wound to remove surface venom but do not massage the wound.

(3) Cover the wound with a mildly compressive bandage. Do not apply strong pressure to the wound.

(4) Immobilize a bitten limb with a splint. Additionally, if the wound is on an upper extremity, use a sling for further immobilization. Avoid movement of the bitten limb as this may result in muscular contraction that will promote systemic absorption of venom.

(5) In the case of snake venom in the eyes, irrigate the eyes and other mucous membranes as soon as possible with a large a volume of water or saline. Any erosions or abrasions should be treated with a topical ophthalmic antimicrobial ointment.

(6) Take the victim to a physician immediately. If this is not possible, call a physician immediately for advice.

(7) A physician must be reached if anaphylactic shock symptoms appear. During transportation or until medical assistance arrives, treat the patient symptomatically.

c. Myths and Actions to Avoid

(1) Venom is not absorbed through unbroken skin.

(2) Application of suction to the bite site does not remove injected venom.

(3) Do not apply a tourniquet, this will only cause and hasten ischemic tissue damage.

(4) Do not do any of the following manipulations to the bite wound: cauterization, incision, excision, amputation, suction by mouth or vacuum pump, injection or instillation of compounds, application of ice, or folk remedies.

4. Birds. Birds cause two main problems: fouling from their feces when they roost indoors, and bird aircraft strike hazard (BASH) on flight lines. BASH is a safety program and any work will need to be coordinated through the BASH program manager.

a. Control. For birds roosting indoors, especially in hangar bays, the solution is the same as for bats: netting or wire mesh suspended from ceiling joists to block access to resting places. Bird spikes will prevent landing but are better suited to ledges or sills on the exterior of buildings.

b. Passive deterrent mechanisms that work by scaring birds, such as sculptures of predators, shiny reflective strips, or loud noises, may have the desired effect in the short term, but will lose effectiveness over time as the birds become acclimated to them. If a bird harassment campaign has failed to dislodge a flock after 4 or 5 days, it is unlikely to work at all and should be reevaluated. Furthermore, harassment without an accompanying program of exclusion and habitat modification will not prevent an area from being recolonized in the future.

8-36. Venomous Arthropods

1. General. Injury produced by venomous arthropods is more common than generally realized. Millions of people in the United States are affected by these arthropods each year. About 25,000 of these envenomizations result in severe injury and about 30 results in death. Clinical manifestations associated with envenomization include anaphylactic shock, hemolysis, necrosis, paralysis, cardiopulmonary dysfunction, allergenic asthma, and antigen induced dermatologic manifestations.

2. Venoms. Venoms produced by arthropods consist of four toxic types: vesicating (blister beetles), neurotoxic (black widow spiders), cytolytic (brown recluse spiders), and hemolytic (horseflies).

3. Venomous Arthropods of Importance

a. Centipedes. Centipedes are fast moving, dorsoventrally flat, elongate arthropods having one pair of legs per body segment. All centipedes contain venom-producing glands that are connected by tubes to claws that are modified appendages on the first body segment. The potential for these arthropods to inflict injury on man is contingent on the size of the claw and its ability to penetrate the skin. Injected venom causes a considerable amount of pain, but rarely death. When death occurs, it is believed to be a result of an anaphylactic reaction. Wounds associated with a centipede sting should be disinfected and a medical officer consulted.

b. Millipedes. These arthropods are slow moving, rounded, elongated arthropods with two pairs of legs per body segment. Many millipedes produce an irritating fluid that may cause skin irritation or even blisters. Some are capable of squirting these fluids some distance and may cause severe injury to the eyes as well as the skin.

c. Scorpions. Scorpions are venomous arachnids that may sting man when provoked. Although few species are deadly, all stings should be considered dangerous and medical attention should be sought immediately. The signs and symptoms associated with these stings vary with species and may include tachypnea, tachycardia, excessive salivation, slurred speech, tissue discoloration, and necrosis.

d. Spiders. Spiders are venomous arachnids and in most cases are considered to be beneficial because they feed on other arthropods. Bites of black or brown widow spiders and the brown recluse spider, are serious and of considerable medical importance. The venom of widow spiders is strongly neurotoxic, causing severe symptoms of extreme pain, abdominal cramping,

profuse perspiration, respiratory duress, and speech inhibition. Only 5 percent of untreated cases are fatal. The venom of brown recluse spiders is strongly hemolytic and vesicating, causing progressive tissue necrosis.

e. Blister Beetles. These beetles are capable of exuding vesicating fluids through the joints of their legs. The active ingredient of this fluid is cantharidin, which is capable of causing blisters and potentially severe chemical burns. As with other blisters, bacterial secondary infection is common. Medical attention for affected individuals is considered important.

f. Hymenopteran Insects. Member species of bees, wasps, yellow jackets, hornets, and ants are high in number and are the most common source of serious envenomization. The stings of these insects can be quite painful. Although the composition of hymenopterans venom varies, most of them have a predominantly hemolytic factor associated with a smaller fraction of neurotoxin. Reactions between individuals exposed to a specific venom may vary considerably. For example, a bee sting may cause no effect, or it may precipitate death. A serious manifestation of hymenopteran hypersensitivity is anaphylactic shock and occasionally accompanied by regurgitation, encopresis, enuresis, rapid decrease in blood pressure, atypically slow pulse, prostration, debilitation and possibly death.

g. Caterpillars. Some caterpillars, the immature stage of butterflies and moths, may cause mild to severe contact dermatitis, nodular conjunctivitis, respiratory pain, headache, and convulsions by injecting hemolytic venom into the skin by the tiny stinging urticating hairs that cover their body. These hairs may also be present on the egg covers, cocoons, and adults. The hairs may become airborne after being broken off or be present in soil after the caterpillar is killed. These hairs may also cause pulmonary inflammation and edema if inhaled. Injury by urticating caterpillars is seasonal, usually occurs in the spring, and is most common among children playing in trees, or shrubbery. The most important of these caterpillars in the United States are the puss caterpillar, saddleback caterpillar, range caterpillar, crinkled flannel moth, and the slug caterpillar. Tape can be used to mechanically remove imbedded hairs or spines in the skin.

4. Allergens. Insect allergens may be a significant causative factor in clinical allergic respiratory involvement, especially of the seasonal allergies. Some insects associated with clinical conditions include mayflies and fungus gnats, which may cause asthma; caddisflies, which may cause asthma and coryza; and bees, which occasionally precipitate hypersensitive airborne particles. Aphids, beetles, and house flies may cause allergic rhinitis or asthma. Stored food insects may be a significant factor in mite dust allergy, while household insects may be a causative factor in house dust allergy.

5. Field Treatment for Envenomization

a. Take the victim to a physician immediately. If this is not possible, call a physician immediately for advice.

b. A physician must be reached if anaphylactic shock symptoms appear. During transportation or until medical assistance arrives, treat the patient symptomatically.

6. Prevention of Envenomization. Prevention of envenomization differs with the species of arthropod involved. The best technique is education to avoid venomous forms. The information given should be pertinent to the biology of the venomous species. For example, individuals hypersensitive to stinging Hymenoptera should wear light colored, smooth fabrics, and avoid leather or suede. It is advisable to keep hair covered, avoid scented cosmetics, stand still when approached by bees, wasps, or hornets, and confine outdoor activity as much as possible to times when temperatures are below 15.6°C (60°F).

7. Surveillance and Control of Venomous Arthropods. Venomous arthropods have diverse habits and habitats, but most are unlikely to become pests of military concern. Because of this, the most useful surveillance program is a complaint-driven one: treatment should take place in response to specific customer requests. Residual insecticides are recommended in these situations. However, because of the diversity of pests and the unique circumstances that might lead to an infestation in a military setting, it is recommended that the area entomologist be consulted when control measures are being considered.

8-37. Bed Bugs

1. General Characteristics. Common bed bugs (*Cimex lectularius*, Figure 06, Appendix B) are hemipteran insects that develop through incomplete metamorphosis, with the juvenile nymphs looking like small versions of the adults. Adults are roughly oval, vertically flattened, brown to reddish-brown insects approximately 1/4 of an inch long, possessing small wing pads, but not capable of flight. Bed bugs harbor in cracks and crevices inside homes or dwellings and thrive in conditions considered comfortable by humans.

a. Bed bugs feed on blood, taking a blood meal every 3 to 5 days. They prefer to feed in the dark but may emerge in light conditions when hungry. Nymphs can survive without feeding for 3 months while adults can survive for longer. Nymphs require at least one blood meal to develop to the next life stage (instar). Adult bed bugs must feed at least once every 14 days to mate and reproduce.

b. Females deposit two to five small, cream-colored eggs per day, and over the course of their adult life may lay 200 to 500 eggs. Under optimal conditions, eggs may hatch in 6 to 10 days and the life cycle may take only 4 weeks to complete, with up to four generations produced each year. At low temperatures the development time from egg to adult may take up to 120 days. The average life span of a common bed bug is approximately 10 months.

c. The related tropical bed bug (*Cimex hemipterus*), darker in color and with a less pronounced pronotum, requires warmer temperatures and is rare in regions outside the tropical and subtropical latitudes. There are other related species known as bat bugs, swallow bugs, and bird bugs that may feed on humans, but do not readily infest dwellings without their primary host (i.e., bats or birds) also being present.

2. Medical Importance. Bed bugs do not vector any human disease. Bed bug symptoms vary greatly from person to person: some show no symptom, while others experience very irritating sores that can become infected at bite site. Those who experience many bites may develop a "sensitivity syndrome" with symptoms of nervousness, agitation, and sleeplessness.

3. Force Protection Risk. Though bed bugs do not vector any diseases, a bed bug infestation during operations can create a force protection risk due to military members not sleeping prior to duty. Due to lack of sleep from being concerned about bed bug bites can cause personnel to be drowsy during watch standing or cause lack of focus causing operationally debilitating mistakes.

4. Surveillance

a. Passive Surveillance. Bed bugs should be surveilled for even when an active infestation is not suspected, especially in berthing areas with high population turnover such as transient barracks. Only traps in the DoD Pest Management Materiels List, found on the Armed Forces Pest Management Board (AFPMB) Web site (https://www.acq.osd.mil/eie/afpmb/), are authorized for bed bug surveillance aboard DoD installations. Consult with NAVENTOCTR or the vector control department of your regional NAVENPVNTMEDU when designing a passive surveillance program. Do not use flushing agents for surveillance as displaced bedbugs may relocate to and infest new areas.

b. Visual Inspection. Conduct a visual inspection when there is a suspected active bed bug infestation. Tools for visual inspection include a flashlight, a black light, a small hand mirror, and a small screwdriver. Signs of bed bug infestations are living or dead bed bugs, eggs, shed skins, and fecal deposits. Fecal deposits appear as dark-colored spots on bedding and in harborages and can be made more visible on dark surfaces by using a black light. In heavy infestations, bed bugs may enter wall voids through the faceplates of wall electrical outlets close to the bed; use a screwdriver to remove the faceplate and inspect the outlet box for signs of bedbugs.

c. Inspection Procedures

(1) Shore Installation Inspections. Inspect all rooms that share a wall with the infested room, as well as the rooms directly above and below the infested room. If the infested room has a door that opens to an internal corridor, inspect the room across from the infested room.

(2) Shipboard Inspections. When inspecting a ship berthing inspect all racks adjacent to the infested rack, all lockers used by the personnel in these racks, and bulkheads in contact with potentially infested racks.

(3) Pre-treatment Inspection. High priority areas for inspection include: mattress seams and creases; mattress parts in direct contact with the bed frame, wall, or bulkhead; cracks and gaps in bed frames and surrounding furniture; and lockers, curtains, and other objects near the rest area. Visually inspect sheets for signs of bed bugs, then place them in a secure bag for removal. If a mattress or box-spring has tears or holes and other signs of infestation are present, assume it is a bed bug harborage and remove it. Prior to moving any item from a suspected infested area ensure it the items are bagged and sealed and mattresses wrapped in plastic in place before removing. Mattresses should be destroyed in a way no one will take the mattress for reuse.

(4) Post-treatment Inspection. Re-inspect infested rooms 48 to 96 hours after treatment. If any live bed bugs are found, re-treat and re-inspect the room. If no live bed bugs are found, leave the room empty for an additional 7 days before re-inspecting. Occupants should not return to their rooms for any reason until the final post-treatment inspection reveals no live bed bugs.

5. Control

a. Physical Control

(1) Vacuuming. Vacuuming, the primary method of physical bed bug control, is effective for removing bed bug adults and nymphs. As vacuuming will not remove eggs or bed bugs in hidden harborages, and provides no residual control effects, it is recommended to utilize additional control methods. If using other control methods, vacuum the area before other control methods are implemented. Collect material from vacuuming in a secure bag to prevent bed bugs from escaping. The recommended type of vacuum for physical bed bug control is a wet and dry vacuum with a HEPA filter; if a different type of vacuum is used, it should not be used for routine cleaning tasks. Discard vacuum contents in trash outside of facility or overboard a ship.

(2) Preventing Spread of Bed Bugs. Personnel occupying potentially infested spaces should not be moved to new accommodations until an infestation is confirmed. Relocated persons should take only required items, be directed to transport their items in duffel bags or other soft bags that can be heat treated prior to relocation and launder all fabric items on high heat before moving.

b. Chemical Control. The AFPMB, Pest Management Materiels List identifies insecticides authorized for use in military facilities. If a pyrethroid insecticide is used, a greater volume of insecticide applied more frequently than typical may be needed to achieve complete control, as many bed bug populations are resistant to pyrethroids. Post-treatment inspection must be thorough to ensure pyrethroid application was effective.

(1) Pre-treatment Procedures. Clean surfaces prior to treatment as chemical insecticides must be applied directly to surfaces where bed bugs may harbor to be effective. Wooden bed frames may be disassembled to allow for direct treatment of cracks and crevices. Remove chair and couch cushions to allow direct treatment of furniture frames. Remove drawers from dressers, nightstands, and desks close to the bed, and empty them of their contents. Take down and launder curtains. If utilizing both vacuuming and spraying, each item should be vacuumed as it is being disassembled.

(2) Pesticide Application. Fabric surfaces may be sprayed with chemical insecticides if they will not be replaced, but care should be taken to avoid saturating the fabric. Do not treat electrical outlets with liquid insecticides; remove outlet face plates and apply insecticidal dusts to the outlet box with a bulb duster to evenly coat the interior surface. Keep windows and doors closed during the spray to prevent bed bugs from escaping.

c. Heat Treatment Control. If chemical control is not preferred, heat treatment is an alternative control method. If this is not available by the command, contact your cognizant NAVENPVNTMEDU for technical recommendations.

(1) Temperature Requirements. Adult and juvenile bed bugs will die after at least 1 minute of direct exposure to temperatures of at least 120ºF. Eggs will be inactivated after at least 1 minute at temperatures of at least 145ºF. As bed bugs will move from high- to low-temperature areas to keep cool, these temperatures must be held for an extended period during heat treatment to ensure all bed bugs are killed.

(2) Laundering Fabrics. Clothing, sheets, curtains, and other fabric objects should be laundered on high heat rather than sprayed to reduce the likelihood of damage. Although American industry standard for laundry dryers is up to 150ºF on the high setting, check if a laundry dryer reaches appropriate temperatures before using it for heat treatment. Bleach is not an effective pesticide when laundering and should not be used as such.

(3) Precautions. Heat treatment has no residual effect, and an incomplete treatment may allow an infestation to persist. Treatment may damage delicate items and materials. Uniformed DoD personnel are not authorized to do heat treatments of spaces.

SECTION VII. DISINSECTION OF NAVAL VESSELS AND AIRCRAFT CARRYING PESTS

8-38. General. Reference (l) requires adherence to the World Health Organization International Health Regulations of 2005. This World Health Organization document defines disinsection (elimination of insects) on vessels and aircraft and discusses procedures to prevent the transfer of live disease vectors from infested to non-infested areas. Disinsection should always be accomplished when leaving ports and airports where yellow fever, malaria, or plague is endemic, and prior to entry where local regulations require disinsection. Commanding officers should be aware of and comply with all applicable domestic and foreign quarantine regulations.

8-39. Disinsection of Vessels. Disinsection of vessels is always performed on those vessels departing foreign ports where vector borne diseases, including yellow fever, malaria, and plague, are endemic or epidemic in the immediate port area. After leaving these areas, the medical officer or the medical department representative trained in shipboard pest control procedures should make a survey to determine whether insects capable of transmitting disease are present aboard the vessel. If disease vectors are present, the commanding officer must be notified and suitable disinsection procedures initiated. Such procedures may include elimination of all standing water sources where mosquito breeding occurs, space treatments with aerosols, or residual application of pesticides. Information on materials and methods for the control of disease vectors and pests aboard naval vessels is found in Section VI.

8-40. Disinsection of Aircraft

1. Geographic Areas Affected. All aircraft, except that part of the cargo section treated following retrograde cargo handling procedures, operated or under the command jurisdiction of the DoD, should be disinsected immediately before the last takeoff prior to entering any country that requires disinsection as indicated in the DoD Foreign Clearance Guide, or any State requiring disinsection per the Japanese Beetle Program (7 CFR § 301.48).

2. Documentation. DD Form 3044 Pre-Embarkation Certificate of Disinsection or country-specific form is used to document all aircraft disinsection. The original form should be kept onboard the aircraft and a copy should be maintained with the aircraft maintenance records.

3. Materials. Insecticide aerosol, 2 percent permethrin, Callington 1-Shot Aircraft Insecticide (NSN 6840-66-131-2263) and Callington Aircraft Insecticide (NSN 6840-01-675-2534), is used to disinsect aircraft.

4. Methods. Disinsection may only be performed by a certified DoD pesticide applicator, or someone who has been trained by a certified applicator to perform specific disinsection duties. Training materials are available at the AFPMB Web site at: https://www.acq.osd.mil/eie/afpmb/index.html. Disinsection must take place after cargo has been loaded and prior to boarding of passengers and crew. The aerosol should be uniformly dispersed throughout the space to be treated by directing it toward the ceiling of the compartment. Baggage compartments, wheel wells, and other areas where insects may find shelter on the outside of the aircraft should be sprayed after loading and boarding operations are completed and just prior to departure. On passenger carrying aircraft, over or store all exposed food, food preparation and service areas, and cooking and eating utensils.

8-41. Special Problems

1. If a question arises as to if disinsection has been successful or if a special problem of insect infestation exists that is not amenable to disinsection procedures herein recommended, a request for assistance should be made by the vessel or aircraft commander.

2. This request should be to quarantine officials at the sea or airport upon arrival or to NAVENTOCTR or the regional NAVENPVNTMEDU. The PHS Foreign Quarantine Branch may require disinsection beyond those of standard directives if an unusual or emergency situation exists.

8-42. Quarantine Procedures

1. Quarantine procedures include measures designed to prevent dissemination of disease organisms infective to plants, animals, and man. Basic regulations and instructions concerning quarantine procedures are presented in reference (l).

2. Per international health regulations, a Ship Sanitation Control Certificate or Ship Sanitation Control Exemption Certificate, reference (k), is required to be maintained by all Navy vessels and may be required for entry into a foreign port as evidence that the vessel is not transporting infectious disease. Valid certificates may only be obtained from qualified inspectors who possess a U.S. Public Health Service seal issued by the CDC. These inspectors are preventive medicine personnel assigned to NAVMEDREADTRNCMDs and NAVMEDREADTRNUNITs, NAVENPVNTMEDU, or a designated ship.

SECTION VIII. PESTICIDE DISPERSAL EQUIPMENT

8-43. Equipment Availability and Suitability

1. There are numerous requirements for pest control equipment because of the variety of organisms, their habitat, and the types of control agents that are to be dispersed. Depending on the control problem, pesticide dispersal equipment is available for either confined or broad areas and for requirements of stationary, portable, vehicular, or aerial equipment use. Because equipment types are continually being modified or developed to meet specialized or changing needs, it is essential to contact the appropriate medical entomologist or applied biologist for recommendations regarding the most appropriate equipment and its authorized use.

2. Article 8-11, Pesticide Formulation and Dispersal, discusses formulations of pesticides, e.g., emulsions, suspensions, and granules, as well as types of pesticide dispersal, e.g., gases, aerosols, and sprays. Table 8-2 on the next page is provided for quick reference on equipment types, applicable formulations, and best scenarios for use. Additional information regarding the use of equipment in the application of specific formulations, types of dispersal equipment, accessory platforms required for transportation such as vehicles or aircraft, and advantages and disadvantages of each is discussed in this section.

3. There are several factors used in determining which spray system will be used for a spray mission. The size, location, habitat, and accessibility of the target area to be sprayed are considered when determining which spray equipment should be used. The size of the area will determine how quickly it can be sprayed and if spraying can be achieved on foot or will require ground transportation. The location may be adjacent to an environmentally protected area, requiring greater drift control that may eliminate the use of aerial spray application. If the habitat has thick vegetation, ULV penetration will be greatly reduced, thus making a residual treatment more effective. The target area may not be accessible by road or may contain numerous flooded acres that cannot be penetrated by ground vehicles, thereby necessitating the use of aerial or manual sprayers. The availability and schedule of the required vehicle or aircraft is another important factor. For example, mosquito control is generally most effective from dusk to several hours after dark. If the desired vehicle or aircraft is available for spray missions at different times, vector control effectiveness will be greatly reduced, possibly necessitating alternative application methods.

Table 8-2. Pesticide Dispersal Equipment and Their Uses

DISPERSAL	FORMULATIONS	TREATMENT	ADVANTAGES AND EQUIPMENT	TYPE LIMITATIONS
Hand-held dust applicators, hand-plungers, foot-pumps	D	Residual	Wt. and cube small. Good for small areas.	Large areas not rapidly treated.
Hand-compressed sprayer	S, E, LV	Residual	Versatile, durable 1 or 2 gallon. Wt. and cube small.	Large areas not rapidly treated.
Hand-held gas or electric ULV sprayers	ULV	Contact	Good for internal spraying.	Expertise needed for use.
Pneumatic backpack sprayers	S, E, LV	Residual	Versatile, durable.	Large areas not rapidly treated.
Gas-powered backpack sprayers	G, D, S, E, ULV	Residual, Contact	Good for barrier sprays.	Expertise needed for use.
Hydraulic sprayers	S, E, LV	Residual	Good for residual treatments.	Generally used for right of ways.
Vehicular-mounted ULV foggers	ULV	Contact	Treats large open areas.	Expertise needed for use.
Air Force modular aerial spray system (fixed wing aerial application system)	LV, HV, ULV	Residual, Contact	Requires fixed wing aircraft, trained crews. Good for large acreage. treatments.	No limitations.

Formulation:

G	=	Granule	LV	=	Low Volume
D	=	Dust	HV	=	High Volume
S	=	Suspension	ULV	=	Ultra Low Volume Solutions
E	=	Emulsion			

4. Hand-held equipment is available in a variety of types designed for various formulations, from ULV to granules. This equipment is generally reserved for smaller areas, or areas not readily accessible to larger pieces of equipment requiring transportation. One advantage to using this equipment is that each piece can be manually carried for application in the target area. The equipment is smaller, reducing the necessary cubic size and weight, which can be used for other surveillance or control equipment and consumables. However, application is limited to the accessibility of the target area to the applicator and the speed and spread of the applied swath width.

5. Backpack sprayers are units mounted on backpack frames for ease of carry and usually gas-powered. Some hand-compressed backpack sprayers are available. Their application rate matches that of the hand-held sprayer, but a larger pesticide reservoir is available. Application with the gas-powered backpack sprayers can range from liquid residuals to dusts and granules. Some backpack manuals claim to achieve ULV aerosol, but dispersal rates and droplet sizes generally exceed those required for flying insect control, providing limited control. Backpack sprayers are carried manually, but hearing protection, gasoline, and engine oil are required. Like the gas-powered hand-held sprayers, two-stroke engine maintenance skills are required. A backpack sprayer has approximately a 2.5 gallon capacity, with additional attachments that allow you to switch from wet to dry applications. The sprayer, spare parts, tools, and miscellaneous accessories usually fit in a six or eight cube authorized medical allowance list can. Where suitable roads are limited but manpower is available, the back-pack sprayer will have some advantages over the vehicular mounted sprayers.

6. Vehicular mounted sprayers are too large to be easily handled by one person. They are mounted or placed on a vehicle or trailer. ULV application is achieved by cold or thermal foggers used in mosquito control. This method provides a contact pesticide control and leaves little or no residual. Hydraulic sprayers apply a HV of residual as demonstrated for fly control at landfills, or residual treatment of vegetation for adult mosquito control or mosquito larvae breeding sites. These larger sprayers are operated by either four-stroke engines or electric motors. A thorough understanding of the equipment is critical for operation, calibration, and maintenance. A vehicle or trailer is needed along with accessibility to the target area, either by road or terrain that allows wheeled vehicles. Some hydraulic sprayers have been mounted in boats for transportation along waterways or lakes. In this way, large areas may be sprayed quickly, allowing for greater protection against disease vectors.

7. The Air Force modular aerial spray system is the only authorized aerial spray system in DoD. It is carried on dedicated C-130s aircraft with specially trained crews and has a 2,000-gallon capacity. It delivers ULV to HV but has no solid formulation dispersal capabilities. This capability allows for extremely large areas, up to 250,000 acres, to be sprayed, but is not feasible or economical for small areas.

SECTION IX. COLLECTION AND PREPARATION OF SPECIMENS FOR SHIPMENT TO MEDICAL LABORATORIES

8-44. Introduction

1. Insects, Other Arthropods, and Vertebrates of Medical Importance. Whenever possible, specimens should be collected for identification and archiving. Specimen acquisition permits development of collections representative of all geographical areas where naval personnel are stationed. These collections then provide a reference source to determine whether, during subsequent surveys, new or existing specimens are found to have moved into or left a specific area. Also, due to geologic variations pertaining to control, the importance of accurate vector and pest species identification cannot be over-emphasized.

2. Data Requirements. To ensure the scientific value of specimens, it is necessary to record all pertinent data at the time of collection. The minimum information that must accompany all specimens is the date collected, the precise location, and the collector. Other important information includes method of collection, elevation, host, habitat, behavior, time of day, specimen coloration, and any significant morphological or ecological observations. All associated data should be kept with the specimens as they are moved, mounted, studied, or shipped. Labels should be written with a soft lead pencil or pen with waterproof ink, and to avoid loss or switching, placed inside vials, tubes, or boxes with the specimens. With pinned specimens the labels should be mounted on the pins below the specimens.

8-45. Procedures

1. Arthropods

a. Dead Specimens. When shipping material by mail, an advance letter should be sent to the addressee notifying him or her of the shipment and its content. The actual shipment, via parcel post, is marked “Dried (or Preserved) Insects for Scientific Study” and “Fragile.” If the shipment is from overseas the statement, “No Commercial Value” will facilitate passage through customs.

b. Live Specimens

(1) Quarantine and Shipping Regulations. If live arthropods or arthropods containing infectious etiologic agents are to be shipped from overseas or interstate, permits may be required by PHS and the U.S. Post Office. To ensure compliance with regulations, refer to references (j) and (k).

(2) Shipment. Delicate insect larvae and adults cannot be easily shipped; therefore, the more durable eggs or pupae should be sent whenever possible. Shipments should be air mailed or sent by special delivery if necessary. Ventilate the package, but make sure the insects cannot escape. Pack carefully and mark the package “LIVING INSECTS” so it will receive special handling. An advance letter should be sent to the addressee notifying him of the shipment and its content.

c. Unpinned Specimens

(1) Mosquito Larvae

(a) Collection. Mosquito larvae are collected to determine the species involved, breeding sites, and relative abundance. The tools used in collecting larvae include a long-handled white enamel dipper, a large mouth pipette, a piece of rubber tubing several feet long, a suction bulb, screw cap vials, pencil, paper, a flat white porcelain pan, and 70 percent ETOH. Collecting techniques vary with the species involved. For free-living species, approach the breeding site carefully because larvae are sensitive to vibrations and shadows. For anopheline species, skim the surface of the water with the dipper. Culicine species are more active and a quick dipping motion with the dipper provides the best results with this group. For a control program, regular larval dipping stations are established so that the average number of larvae per dip can be used as an index of control effectiveness. Container, tree hole, crab hole, and leaf axil breeders can be collected with a pipette or aspirated with a suction bulb attached to a piece of rubber tubing. Mansonia and Coquillettidia larvae are collected by pulling up aquatic vegetation (sedges, cattail, etc.), which is rinsed in a pail of water. Since the larvae drop off of the plant quickly it may also be productive to scoop up samples of bottom sediment with a bucket and rinse this material with a strainer. Transfer the rinse and strained water in small amounts to a small porcelain pan and examine it closely for larvae.

(b) Curation. Never mix specimens collected on different days or from different breeding sites. Concentrate all of the larvae from a single collection in 2.5 ml (1 in) of water in a small test tube, and heat it with a match or a Bunsen burner until bubbles begin to reach the surface. Pour the contents into a small open container. Pick up the larvae on the point of a probe or insect pin and drop them into a Novocain tube containing 70 percent ETOH. These tubes may be obtained from dental facilities. Isopropyl alcohol (70 percent) may be temporarily substituted as a preservative but it should be replaced with ETOH when possible to preserve specimen quality. Insert a small, loosely compacted piece of cotton into the tube at a point just above the larvae and well below the surface of the alcohol. Write the collection data with a soft lead pencil or pen with indict ink on bond paper labels. When using indict ink, allow the label to dry. Then push the label into the tube above the cotton. Insert the top Novocain tube stopper using a needle to release the compressed air. Make sure that no bubbles exist in the section of the tube holding the larvae because repeated passage of air bubbles over specimens can cause damage. One week following preservation, re-examine the tubes. If bubbles have formed, release the trapped air with a long needle. Wrap the tubes carefully in cotton or other soft packing material and package them in a crush-proof container for mailing.

(2) Mosquito Adults

(a) Collection. The collection of adults requires consideration of the species' behavior. Since no single method attracts all species, a combination of methods is desirable. Light traps attract phototrophic species. The New Jersey light trap is widely used for this purpose. Basically it is an open metal cylinder protected by a conical top. An electric fan draws the insects attracted to a 25-40 watt white light, into a collecting jar containing a piece of dichlorvos strip or paradichlorobenzene. A perforated paper cup suspended from the rim of the

jar keeps the mosquitoes dry, clean, and easy to remove. The fan in a New Jersey light trap requires 110 volts and can be turned on and off by an electric timer or photo-electric cell. Another type of trap is the CDC or solid state Army miniature light trap that weighs only about 0.8 kg (1/3 lb) and can be operated on any 6 volt DC source. The use of a 30-amps an hour-motorcycle battery gives up to 5 nights' operation without recharging. The live adults are collected in a cage of nylon netting and can be used in virus isolation studies. Proper trap placement is very important. Place the traps about 1.5 to 1.8 meter (5 to 6 feet) above the ground, and avoid competing light sources, windy areas, and industrial fumes. Also avoid trapping in livestock and bird roosting areas because mosquitoes are less easily attracted to light after taking a blood meal. Optimum results will be obtained in areas with adequate vegetation and high humidity. A shift of a few meters can make a substantial difference in results. Therefore, if trapping results are poor, change the trap locations before reporting the absence of mosquitoes in the area. In addition to indicating what species are present, trapping signals the emergence of males that emerge before the females and congregate near the breeding site. This allows treatment of a population before a major increase in the number of adult females occurs, thus, lowering the breeding potential. For some of the Anopheline species that are not strongly attracted to lights, collections are made at resting sites. This is done by sweeping the vegetation with an insect net or by using an aspirator (or killing tube) and a flashlight. The aspirator is made of rubber or plastic tubing joined to a piece of rigid clear plastic tubing [0.9 centimeter (0.37 inch) inside diameter] with a piece of netting in between for a filter. Cool, dark, and humid areas are checked, including culverts, bridges, caves, overhanging stream banks, wells, and buildings. In areas with few resting sites a variety of artificial devices such as boxes, barrels, and kegs can be established.

(b) Curation. Adult mosquitoes are very delicate and must be handled carefully to avoid loss of scales or appendages essential to their proper identification. Natural scale discoloration, caused by moisture, must also be prevented. Consequently, to avoid contact with moisture that condenses in ethyl acetate or chloroform killing tubes when exposed to heat or the sun, remove the mosquitoes as soon as they are killed and periodically wipe the barrel of the tube dry. Reared adult specimens to be preserved should be kept alive for at least 12 hours to allow them to harden, and then pack them in pill boxes. Pillboxes are preferred over glass, plastic, or metal containers because they are permeable. This helps to prevent any fungal growth caused by a buildup of excessive moisture from the drying specimens and heat from the environment. Prepare the box for shipping by cutting two strips of soft tissue paper slightly larger than the lid. Place a thin, very light wisp of cotton in the bottom of the box and cover it with one paper slip. Being slightly larger than the box, the paper’s tucked edges against the sides will hold it firmly. Place the collected mosquitoes on this paper and tuck in the second paper slip until it just contacts the mosquitoes. Be sure the covering slip will not become dislodged. Over the top paper slip, add another wisp of cotton that is barely large enough to touch the lid when it is closed. Do not, under any circumstances, pack mosquito adults between layers of cotton, cell cotton, or similar fibrous and heavy materials. The collection data should be placed within the container between the lid and the top layer of cotton. Data may also be recorded on the lid of the container. Placing the containers in an excelsior-padded and properly labeled mailing tube completes packing.

(3) Flies. Adult flies can be collected with an insect net or a variety of traps. If a natural attractant is available use a 76 millimeters (3.0 inch) diameter wire screen cone with an inverted screw top to trap domestic flies. Place the cone over the attractant and flies. Then place a dark cloth over the cone. The cone is then agitated and the flies will move upward toward the light in an effort to escape. The sliding door of the trap is then closed, blocking the mouth of the bottle. Lacking a natural attractant, all-purpose baits consisting of a mixture of fish heads, chicken entails, vegetables and fruit may be used. The cylindrical screen trap placed several inches above the bait should have a funnel shaped, upward pointing bottom, and a removable top. As the flies leave the attractant, they are funneled into the trap. Since they generally do not fly downward to escape and the funnel opening is difficult to find, few flies will escape. Fly larvae (maggots) and adult specimens of delicate flies, such as sand flies, culicoid biting flies, eye gnats and black-flies, may be preserved in 70 percent ETOH as described for mosquito larvae. Larger flies, such as domestic species, should be preserved in dry pill boxes as detailed above for mosquito adults, except that heavier cotton cushion layers will be needed because of the greater weight of the specimens involved.

(4) Ectoparasites. Particular effort should be made to collect ectoparasites from wild rodents suspected of being reservoirs of disease (e.g., plague, tularemia, etc.). Because fleas leave the host shortly after death, it is best to capture the animal alive and sacrifice it via cervical dislocation and place in a closed container with a dichlorvos strip from which the detached insects can be collected. Leave the animal in the container at least 30 minutes after death to ensure that the ectoparasites have also been killed by the insecticide exposure. A fine- tooth comb is used to comb fleas onto white paper. Another technique for collecting fleas, as well as some mites, is to place the dead host in a jar of water containing a detergent and swirl the water vigorously. After filtering the water with a filter paper lined funnel, place the specimens in 70 percent ETOH as described for mosquito larvae. Neither combing nor detergent baths will remove stick-tight fleas or ticks. These must be picked off with forceps during a thorough host examination. When examining buildings for adult fleas, white pants or coveralls will allow the adults to be seen quite readily when they move onto the legs. They can then be collected with a small alcohol moistened brush. When examining animals for ticks, care must be taken in their removal so that the mouthparts are not broken in the host's skin. Ticks may be collected from likely host habitats by walking through grassy or bushy areas and removing them with forceps from the clothing or from a piece of cloth used as a drag. The latter is constructed by attaching a piece of white flannel about 1 x 1.5 meters (1 x 1.5 yards) by two corners to a stick approximately 1 meter (1 yard) long. A cord is attached to both ends and the device is dragged over grassy areas beside trails and other potentially infested areas. The same device without the cord can be brushed over shrubbery. Collected ticks are placed in 70 percent ETOH. The detergent technique described for fleas yields some mites but chiggers are collected by scraping the skin or, in the case of dead animals, portions of infested skin may be cut off and preserved in alcohol. Another method is to place a white or black card on the ground. Mites are counted and collected with a small, alcohol moistened brush as they cross the card. Lice and bed bugs may be collected from clothing and bedding with forceps or combed from the hair with a fine-tooth comb and placed in 70 percent ETOH.

(5) Miscellaneous Arthropods. Insect larvae spiders, scorpions, centipedes and millipedes may be preserved in vials of 70 percent ETOH. When lids are closed parafilm can be used to seal the lids to prevent fluid loss through evaporation. If 5 percent glycerin is added to the 70 percent ETOH, the collected specimens will not shrivel, shrink, or dry if the alcohol is accidentally lost. Larger, hard bodied insects such as reduviid bugs, cockroaches and beetles should normally be preserved dry in pill boxes but they can also be placed in tubes or vials of 70 percent ETOH.

d. Pinned Specimens. If possible, it is usually better to pin insects for mailing because they are less likely to break if properly packed. These specimens may be pinned inside a closed vial with a cork bottom or in a Schmitt, cigar or other sturdy box with a cork, balsa wood, corrugated cardboard or composition bottom. The pins should be securely anchored in the substrate. Large specimens should be braced with additional vertically placed pins to prevent them from rotating and destroying adjacent specimens. Insects with elongated abdomens should be supported with crossed pins, thereby preventing the abdomens from breaking off in the event of rough handling during shipment. For ease of extraction, the cardboard can be slotted, or a piece of adhesive tape can be attached to the center for use as a handle. Fasten the lid securely and pack the box or boxes in an outer stout carton padded with a lining of excelsior, styrofoam or similar packing at least 5 centimeters (2 inches) thick.

8-46. Disposition of Collections

1. Collection of specimens should be sent to the appropriate NAVENPVNTMEDU or NAVENTOCTR for identification.

2. Complete data should always accompany the shipments. An advance letter of shipment notification, an appropriate request for services, and any comprehensive and pertinent questions for which answers are specifically required should also be sent.

CHAPTER 8
NAVY ENTOMOLOGY AND PEST CONTROL TECHNOLOGY

APPENDIX A
ENTOMOLOGY AND PEST CONTROL REFERENCES AND RESOURCES

References

(a) DoD Instruction 4150.07, DoD Pest Management Program of 26 December 2019 is available at: https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/415007p.pdf

(b) OPNAVINST 6250.4C, Navy Pest Management Programs is available at: https://www.secnav.navy.mil/doni/Directives/06000%20Medical%20and%20Dental%20Services/06-200%20Preventive%20Medicine%20Services/6250.4C.pdf

(c) OPNAVINST 5090.1E, Environmental Readiness Program is available at: https://www.secnav.navy.mil/doni/Directives/05000%20General%20Management%20Security%20and%20Safety%20Services/05-00%20General%20Admin%20and%20Management%20Support/5090.1E.pdf

(d) NAVMED P-5052-26, U.S. Navy Shipboard Pest Management Manual is available at: https://www.med.navy.mil/Portals/62/Documents/BUMED/Directives/All%20Pubs/5052-26.pdf?ver=eJlMKJTNKX4FanXhz6xUgQ%3d%3d

(e) DoD Manual 4150.07, Volume 2, DoD Pest Management Program Elements and Implementation: Pesticide Applicator Training and Certification Program of 22 January 2022 is available at: https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/415007_vol2.PDF

(f) BUMEDINST 6250.12D, Pesticide Applicator Training and Certification for Medical Personnel is available at: https://www.med.navy.mil/Portals/62/Documents/BUMED/Directives/Instructions/6250.12D.pdf

(g) COMNAVSURFORINST 6000.1, Shipboard Medical Procedures Manual available at: 6000.1.doc (navy.mil)

(h) DoD Manual 4150.07, Volume 1, DoD Pest Management Program Elements and Implementation: Structure and Operation of 22 January 2020 is available at: https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodm/415007_vol1.pdf?ver=2020-01-22-132922-467

(i) Armed Forces Pest Management Board (AFPMB) Technical Guide No. 15, Pesticide Spill Prevention and Management of July 2021 is available at: https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg15.pdf

(j) MIL-STD-904C, Department of Defense Standard Practice: Detection, Identification, and Prevention of Pest Infestation of Subsistence, available at: https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=36040

(k) AR 40-657/NAVSUPINST 4355.4H/MCO P10110.31H, Veterinary/Medical Food Safety, Quality Assurance, and Laboratory Service is available at: https://armypubs.army.mil/ProductMaps/PubForm/Details.aspx?PUB_ID=19

(l) OPNAVINST 6210.2A, Quarantine Regulations of the Navy available at: https://www.secnav.navy.mil/doni/Directives/06000%20Medical%20and%20Dental%20Services/06-200%20Preventive%20Medicine%20Services/6210.2A.pdf

(m) BUMEDINST 6210.4, Ship Sanitation Certificate Program is available at: https://www.med.navy.mil/Directives

Department of Defense Resources

DSCPI 4145.31, Integrated Stored Product Pest Management is available at: https://www.dla.mil/Portals/104/Documents/TroopSupport/Subsistence/Rations/qapubs/instructions/4145-31_Oct17.pdf

DD Form 1222, Request for and Results of Test is available as a PDF download at: https://www.esd.whs.mil/Directives/forms/dd1000_1499/

Department of the Navy Resources

NAVSUP Pub 486, Chapter 5, Receipt, Inspection and Stowage is available with an account at: https://my.navsup.navy.mil/apps/ops$nll.view_publication_details?P_PUBLICATION_ID=6088/ (If you do not have an account, you will need to register one)

Armed Forces Pest Management Board Resources

Technical Guide No. 24, Contingency Pesticide Usage Guide is available, with CAC, at: https://extranet.acq.osd.mil/eie/afpmb/cac/techguides/tg24.pdf

Technical Guide No. 36, Personal Protective Measures Against Insects and other Arthropods of Military Significance is available at: https://www.acq.osd.mil/eie/afpmb/docs/techguides/tg36.pdf

METRIC CONVERSION EQUIVALENTS APPLICABLE TO THIS CHAPTER

1 centimeter (cm)	0.39 inches (in)	1 cubic centimeter (cc)	0.03 fluid ounces (fl oz)
1 meter (m)	3.28 feet (ft)	1 milliliter (ml)	0.03 fluid ounces (fl oz)
1 meter (m)	1.09 yards (yd)	1 liter (l)	0.26 gallons (gal)
1 knot	1.15 miles/hour	1 gram (g)	0.35 ounces (oz)
1 kilometer (km)	0.62 miles (mi)	1 kilogram (kg)	2.20 pounds (lb)
1 hectare	2.47 acres		

APPENDIX B
SELECTED FIGURES

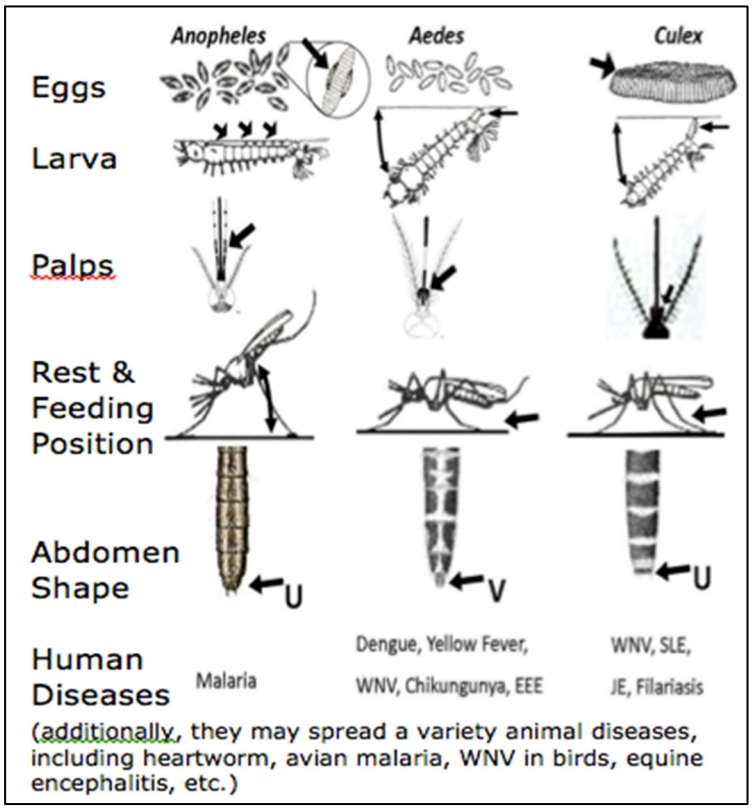

Figure 01. Comparisons between the common mosquito genera of medical significance.

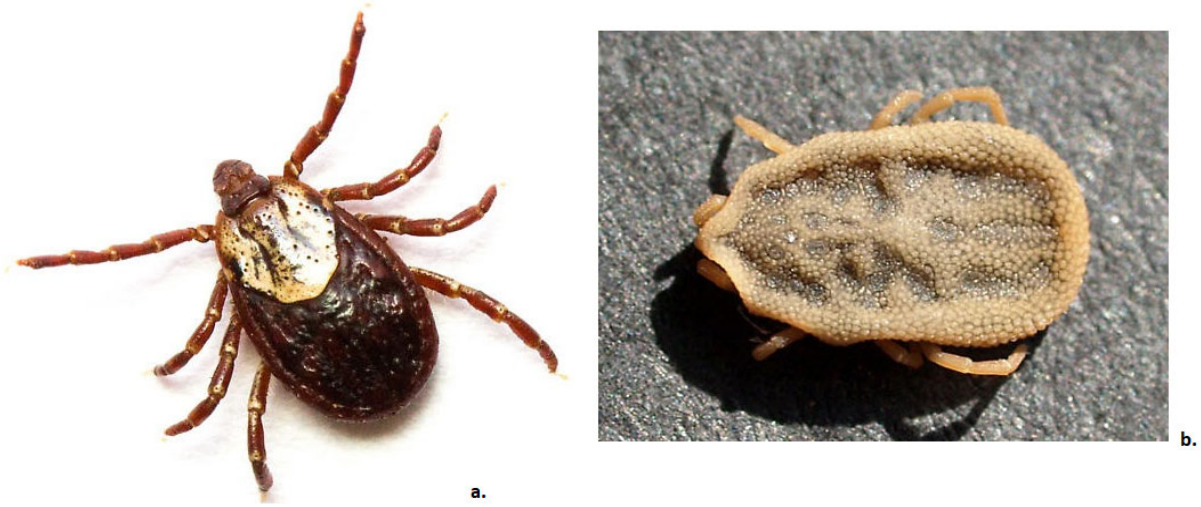

Figure 02. Comparison between hard ticks (a) and soft ticks (b).
Images courtesy of bugguide.net.

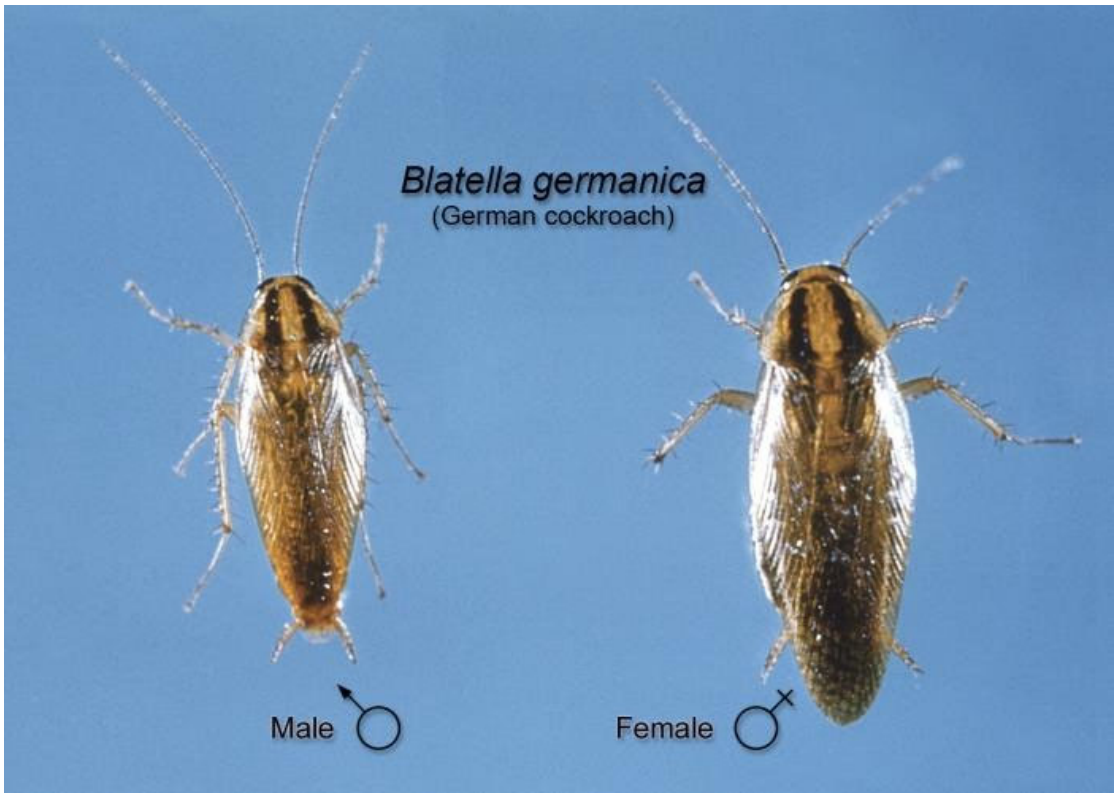

Figure 03. Male and female German cockroaches.

Figure 04. *Dermestid* beetle larva. **Note** the fine hairs on the beetle's back.

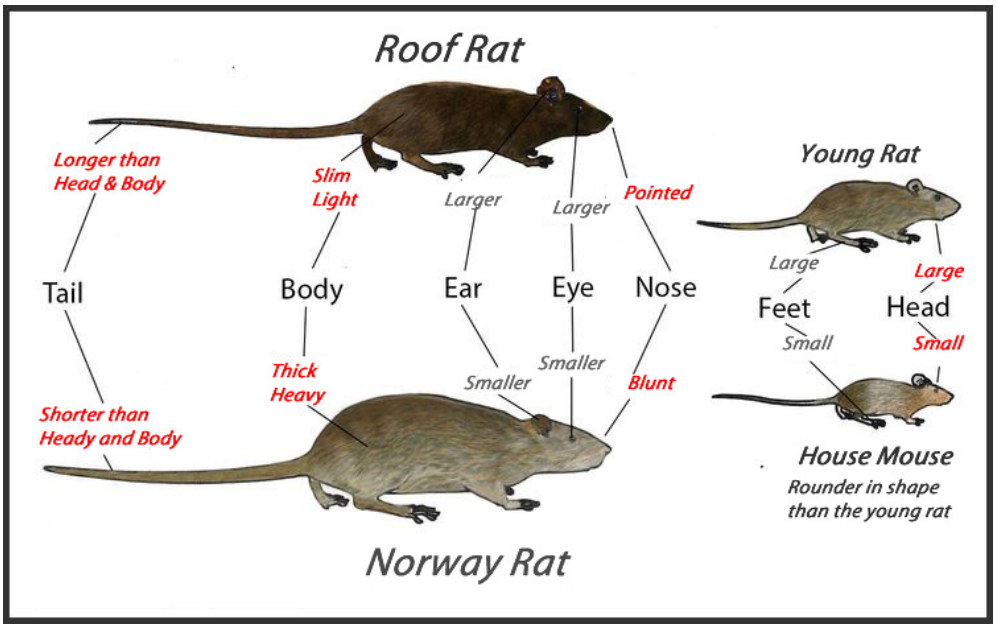

Figure 05. Comparison of rats and mice of military importance.

Figure 06. Two species of *Cimex*-genus bedbugs. Image courtesy of Aix Marseille University.

APPENDIX C
FORMS

1. DD Form 1826 Pest Control Certificate of Competency is available by contacting osd.pentagon.ousd-a-s.mbx.cmo@mail.mil

2. DD Form 3044 Pre-Embarkation Certificate of Disinsection is available at: https://www.esd.whs.mil/Portals/54/Documents/DD/forms/dd/dd3044.pdf

3. DD Form 1222 Request for and Results of Test is available at: https://www.esd.whs.mil/Directives/forms/dd1000_1499/